SILICON CHIP

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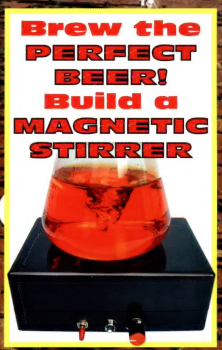
Maximite meets Arduino

TV Audio Delay – fix lip sync!

Mini Variable Voltage Regulator

Professional Loudspeaker Testing – using your PC!



Thousands of dishes - One radio telescope

Australia bids for SKA: the World's Largest Telescope

All I want for Christmas is...
Hardcore Electronics
DECEMBER 2011

ULTRASONIC ANTIFOULING FOR BOATS

Marine growth electronic antifouling systems can cost thousands. This project uses the same ultrasonic waveforms and virtually identical ultrasonic transducers mounted in a sturdy polyurethane housings. By building it yourself (which includes some potting) you save a fortune! Standard unit consists of control electronic kit and case, ultrasonic transducer, potting and gluing components and housings. The single transducer design of this kit is suitable for boats up to 10m (32ft); boats longer than about 14m will need two transducers and drivers. Basically all parts supplied in the project kit including wiring. (Price includes epoxies).

- 12VDC
- Suitable for power or sail
- Could be powered by a solar panel/wind generator
- PCB: 78 x 104mm

KC-5498

SOLDER FUME EXTRACTOR

Designed to remove dangerous solder fumes from the work area. Suitable for use in production lines, service centres, R&D workbenches or the hobbyist. It incorporates a ball bearing high volume fan to maximise airflow which is directed upwards at the rear of the unit to aid in safe operation.

- ESD safe
- Dimensions: 260(H) x 200(W) x 170(D)mm

TS-1580

PCB HOLDER WITH MAGNIFYING GLASS

Any time you need that extra bit of help with your PCB assembly, this pair of helping hands will get you out of trouble. With a 90mm magnifying glass, it also provides an extra pair of eyes.

- Dimensions 78(L) x 98(W) x 145(H)mm

TH-1983

ATTENTION KIT BUILDERS

Kit Back Catalogue

If you can't find the kit you are looking for, try the Jaycar Kit Back Catalogue. Our central warehouse keeps a quantity of older and slow-moving kits that can no longer be held in stores. A list of kits can be found on our website. Just search for "kit back catalogue".

12/24VDC 20A MOTOR SPEED CONTROLLER KIT

Control the speed of 12 or 24VDC motors from zero to full power, up to 20A. Features optional soft start, adjustable pulse frequency to reduce motor noise, and low battery protection. The speed is set using the onboard trimpot, or by using an external potentiometer (available separately, use **RP-3510** $2.85).

- Kit supplied with PCB and all onboard electronic components
- Suitable enclosure UB3 case, **HB-6013** $3.95 sold separately

KC-5502

DAB+/FM DIGITAL RADIO KIT

Covers DAB+ and FM, has analogue and optical audio outputs, IR remote (included), an external antenna connector and is powered by mains plugpack. The kit is complete with everything, including the case. See website for full specs.

- Digital station info display
- RCA and optical audio output
- External antenna connection
- Station memory presets
- BVAC plugpack inlcuded

KC-5491 WAS $399.00

DESKTOP LED MAGNIFYING LAMP

Sixty LEDs provide ample illumination, perfectly even light and the 3x and 12x magnifying lenses will show all the detail you need. Being LED, there's no delay in startup and they'll never need replacing. Ideal for hobbies, modelmaking or jewellery.

- Dimensions: 320(H) x 95(Dia.)mm

QM-3544

48W SOLDERING STATION

Ideal station for the advanced hobby user. It features accurate analogue temperature adjustment, ceramic element and a lightweight pencil that will give you hours of fatigue-free soldering. The stand has spare tip storage and is very sturdy. See our website for full specs.

- Temperature range: 150 - 450°C
- Dimensions: 150(L) x 115(W) x 92(H)mm

TS-1564

Spare parts also available:
Pencil:
TS-1565 $39.95
Tips:
0.5mm Conical
TS-1566 $9.95
2.0 mm Conical
TS-1567 $9.95

ULTRASONIC WATER TANK LEVEL INDICATOR KIT

Designed for plastic and concrete tanks, or steel tanks with modification, this water level indicator kit uses an ultrasonic assembly that mounts inside the tank and a microprocessor controlled meter to display the water level. Selectable between 10 LED Bargraph or 19 level Dot mode. Easy to calibrate, can be pushbutton or permanent display, powered by a 9V battery or power adaptor (available separately) and can be used with fluids other than water. Kit includes PCB, waterproof case and all electronic components. Silicon sealant not included.

- Suits tanks up to 2.4m high
- PCB: 104 x 78.5mm

KC-5503

DMM HEAVEN

40,000 Count IP67 True RMS CAT IV DMM with Wireless USB and Storage

This meter can be used as a data logger with its data storage capability, which can then be connected to a PC via wireless USB interface keeping the PC completely isolated from whatever is being measured. Triple LCD backlit screen with bargraph, data hold, 4-20mA process loop measurements, capacitance range. A truly fantastic multimeter designed to last you several years out in the field.

- True RMS, wireless USB PC interface
- PC logging software
- 9999 measurement storage
- Auto power-off
- Relative measurement
- Diode test, autoranging
- Audible continuity
- 10A current range
- Dimensions: 182(H) x 82(W) x 55(D)mm

QM-1575

CAT III 2000 Count Inductance/Capacitance DMM

Ideal for audio enthusiasts designing their own crossovers. Features large LCD, inductance, capacitance, data hold, auto power-off, and temperature measurement.

- Display: 2000 count
- hFe transistor test
- 10A AC & DC current
- Diode test
- Audible continuity
- Dimensions: 195(H) x 92(W) x 55(H)mm

QM-1548

HEAVY DUTY JUMPER TEST LEAD

This set has large alligator clips and heavy cable.

- Jaw openings of about 10mm
- Cable length is approx 300mm
- 10 leads supplied, 2 of each colour

WC-6020

All Savings are based on Original RRP

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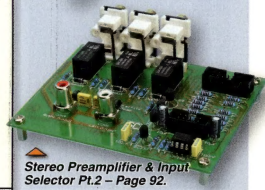

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Publisher & Editor-in-Chief
Leo Simpson, B.Bus., FAICD

Production Manager
Greg Swain, B.Sc. (Hons.)

Technical Editor
John Clarke, B.E.(Elec.)

Technical Staff
Ross Tester
Jim Rowe, B.A., B.Sc
Nicholas Vinen

Photography
Ross Tester

Reader Services
Ann Morris

Advertising Enquiries
Glyn Smith
Phone (02) 9939 3295
Mobile 0431 792 293
glyn@siliconchip.com.au

Regular Contributors
Brendan Akhurst
Rodney Champness, VK3UG
Kevin Poulter
Stan Swan
Dave Thompson

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Editorial office:
Unit 1, 234 Harbord Rd, Brookvale, NSW 2100.

Postal address: PO Box 139, Collaroy Beach, NSW 2097.

Phone (02) 9939 3295.

Fax (02) 9939 2648.

E-mail: silicon@siliconchip.com.au

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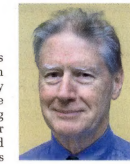
Publisher's Letter

Domestic solar panels can make electricity grid unstable



With all the controversy over solar grid feed-in tariffs and renewable energy certificates, yet another problem with domestic solar panels has arisen. According to a story in *The Australian* newspaper on 13th October 2011, "The runaway take-up of rooftop solar panels is undermining the quality of electricity supplies, feeding so much power back into the network that it is stressing the system and causing voltage rises that could damage household devices such as computers and televisions. Power distribution lines and home wiring were designed for electricity to flow from power stations to appliances, but households with solar panels do the reverse of this".

This is an interesting concept and one which someone familiar with electronics might initially dismiss. After all, the electricity grid is not like a diode, is it? Why shouldn't it be able to handle power flow from solar panels into the grid? In principle, if there was a small amount of "solar" electricity being fed back into the grid, it would not cause a problem; the power stations would simply generate less power to compensate and everything would be in equilibrium. And we would saving all those nasty "carbon" emissions, wouldn't we?

But as always, things are not that simple. It neglects the fact that the electricity generated in all the power stations has to travel long distances via high voltage lines and various substations and step-down transformers in the streets before it arrives at the customers' meter boxes. And it is the substations and street transformers which are the basis of this problem.

Basically, the energy retailer is able to compensate for local voltage variations in suburbs and streets as energy consumption varies throughout the day but overall, only a limited range of adjustment is possible by tap-changing on the transformers throughout the system. Then what happens if you have large numbers of domestic solar panels in a suburb generating lots of power during the day when consumption may be low? The voltage will inevitably rise, perhaps to levels which are well above what they are supposed to be. The consequences could easily be wholesale damage to domestic appliances and possibly to the grid-feed inverters which at the very least, should switch off.

So what can be done about that? Now, while the electricity retailers can actually "dump" load if the system becomes overloaded, there is presently no way to disconnect domestic solar installations if the system voltage becomes excessive. In the meantime, according to the story in *The Australian*: "In Western Australia, Horizon Power has set limits on how much renewable energy can be installed in a system without affecting the power supply. Horizon is rejecting applications for new renewables installations in Exmouth and Carnarvon.

"Energex spokesman Mike Swanston said it was becoming difficult for electricity distribution authorities to set up the power system to ensure correct voltages when some houses in a street had solar and others did not".

Ultimately, this problem might be solved by a change in the design of grid-feed inverters: once the voltage coming in from the street rises above (say) 245VAC, the inverters would be switched off and would no longer be able to generate power. This would protect other consumers but of course, those people who invested in solar panel installations would not get the full benefit. Worse, they might have to pay for power which, if the system voltage was below the threshold, they would otherwise be generating.

This is yet another instance of the impracticality of the Green's advocacy of Australia generating all its electricity from renewable sources. For this and a whole host of other technical reasons, it just ain't ever going to happen.

Leo Simpson

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Loudspeaker fire: a close escape

Seeing the speaker on fire on the October 2011 cover made me remember an incident that occurred a few years ago now, which could have had dire consequences. It is worth telling for several reasons.

I was working late in the home workshop shed and at around 11:00pm heard a rather loud noise disturbing the neighbourhood and I immediately wondered about the sanity of whoever was running a compressor or mower at that time of night. After about 10 seconds of this I realised that the noise was in fact coming from my house.

I went inside just as the noise abated somewhat and was still led to the home theatre room where there was now a bad smell, smoke and finally a lick of flame coming from the active sub-woofer port. This unit was a US Audio-branded device and was in standby mode at the time it cremated itself. I unplugged the unit, extinguished it and put it outside for investigation next day.

When I got it apart I noted that the fuse was still intact but that both the speaker driver and the amplifier had been alight. The PCB for the amplifier was very crispy and not much was recognisable in the way of components. The speaker cone had suffered burning at the centre but the voice coil was still continuous.

This was not the first time I have been directly involved with consumer electronics in standby mode catching fire, with PC monitors and TVs being quite common. This is the reason I now have a real switch to remove all power to most devices around the home.

The subwoofer in question was rated at 60W RMS and this low power is why I believe it burnt so well, as there was not quite enough current to open the voice coil or fuse but still enough to produce sufficient heating to make flame and to do so within about 40 seconds of the fault occurring.

I was lucky; I was home at the time! How many people leave these things on standby even when away on holiday? With a fire just waiting to happen? Since that time I have seen one other subwoofer with very charred innards and I wonder about the general safety of these units.

David Woodbridge,
Camillo, WA.

Tamper-proof screw solution with an angle grinder

I read the Serviceman story in the September 2011 issue that Leo Simpson had trouble with tamper-proof screws.

Well it does not matter how tamper proof they make things, we will find a way to get them apart. To cater for such circumstances, I have converted my tamper-proof bits into adapters by cutting a slot with a 1mm thick cutting disk mounted in an angle grinder. I always have these 125mm diameter disks on hand as I use them for all my metal cutting (up to 12mm plate would you believe?).

Anyhow all you do is drop the modified bit down into the recess and then undo the screw with a flat bladed screw driver using the slot in the top of the bit.

Ron Groves,
Cooloola Cove, Qld.

Comment: another reader has commented that long-shaft tamper-proof screwdriver bits are available on eBay.

Sampling rates are adequate – compression is the problem

Over the last few years you've published a number of letters about perceived problems with DAB+ audio quality. You've also expressed similar views in your Publisher's Letter, most recently in October 2011.

Not surprisingly, most of the views expressed have come from those on the receiving end of the signal chain, with one exception being a letter in May 2010 from Steve Adler, for many years Technology Director at DMG Radio.

My own experience spans some decades with several community stations in Melbourne. I maintain an AM station and also care for the digital

DAB+ programs degraded by excessive compression

Many readers have commented about the dubious sound quality of DAB+ transmissions by the commercial stations and ABC/SBS, as compared with FM transmissions but my concern is about the dynamic range of these. I understand that a great majority of radio stations since the introduction of FM in Australia have applied 1:1.4 compression to the high end of their source material. They do this because the great majority of listeners are listening to radios with tiny speakers (eg, clock radios) and this compression would suit many such listeners because they have no particular interest in the wide dynamic range that the music artist/company intended them to listen to.

DAB+ would be the same. Any mention of CD-type quality being associated with FM or DAB+ transmissions is not true if radio stations apply some compression, although I believe that ABC Classic does not apply such compression to their source material. Therefore, apart from bit rates being an issue for DAB+, there is also the issue of dynamic range compression.

Brian Collath,
Moss Vale, NSW.

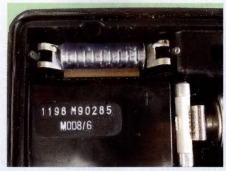
Comment: we understand that ABC Classic FM and 2MBS FM in Sydney are the only two FM broadcasters who do not use compression.

Another battery solution for an Avometer

I was delighted to read Barry Grumwald's article (Circuit Notebook, November 2011), in which he described an arrangement for replacing the 15V battery in an Avo Mk8 multimeter. I recently bought one of these much-loved meters (Avometer 8, Mk6), in which the battery compartment is quite differently shaped. Unfortunately, his solution of using five CR2032 cells does not fit.

Nonetheless, I was inspired to explore a similar solution, using 10 SR41W silver oxide cells. These fit snugly inside a 33mm length of PVC tubing (11mm OD, 8mm ID), supported by an 8mm thick 33 x 13mm wooden packing piece, as shown in the accompanying photo. The 10 cells fit snugly between the battery clips, which do not need any modification.

While my solution is more expensive, current is only drawn from



the batteries during actual measurements, so they should last for close to their shelf life.

James Goding, VK3DM, Princes Hill, Vic.

Another battery solution for an old multimeter

In your November 2011 magazine J. Grumwald advised how he had used five CR2032 cells to replace the unobtainable 15V battery in his Avo Mk8 multimeter.

I have a beautiful Salford "Selectest" model Super 50 multimeter which is over 50 years old but still looks and performs like new. I had the same problem as J. Grumwald in that the Selectest was designed to use an Eveready B.121 15V battery for the high Ohms range. I am not sure but possibly this was also the battery used in the Avo.

These batteries are no longer available but I have found what I believe to be a simpler solution in a Varta V74PX 15V battery (readily available) which is about the same size as the original B.121. The only difference is that the B.121 had pointed ends which located in holes in the spring terminals in the meter and the V74PX has normal ends, as seen in standard 1.5V batteries. I have satisfactorily got over this problem by adding a little blob of solder on each end of the battery to engage the holes.

Barry Blackman, Beaconsfield, WA.

studios and audio processing for an FM fine music station. In both stations we've recently installed DAB+ encoding equipment and listened with great interest on various receivers that are essentially just DSPs with an RF preamp and D-to-A converter.

I very much endorse Steve's Adler's observation that "DAB+ bit rates of 48kb/s and higher, with light audio processing applied, can sound very good indeed!" I'd also note that no service in Melbourne now runs above 80kb/s, not just for reasons of channel space but also because there is little to be gained. HE-AAC is optimised to outperform other codecs at lower bit rates and my own observations very much tally with the research Steve cited. Rates above 80kb/s are basically wasting data.

Many contributors have been adamant that 64kb/s is inadequate, although no-one has described precisely what this inadequacy is. Like all lossy bit rate reduction systems, the HE-AAC codec used in DAB+ declines in quality as the rate reduces. At low rates, HE-AAC does, like MP3 and siblings, produce that "swishy" effect on treble content, though that's masked to some extent by the its Spectral Band Replication which re-synthesises the top half of the audio spectrum. More apparent to my ears is an increasing "choppiness" in the high frequencies which sounds like packetisation.

It's curious to me that no-one has actually described these artefacts in their criticisms of DAB+ audio quality. It makes me wonder if other factors are coming to bear on how people perceive what they're hearing. As an example, Australian HiFi magazine published an article in their July-August 2011 edition by Timoshenko Aslanides, comparing the sound of a Canberra station on AM (stereo, still!) and DAB+.

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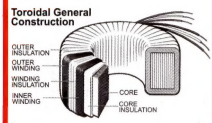

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Mailbag: continued

He described their DAB+ at 64kb/s as "metallic – hollow even – and hard-edged" while with a wide-band AM receiver "the [station's] AM Stereo was warm, inclusive and solid".

I own several wideband AM stereo receivers, and even built David Tilbrook's remarkable TRF design of many years ago. Sure, AM can sound pretty decent if all the planets are aligned. But the above observations are completely at variance with my own.

So what's going on? One factor Steve Adler hinted at above was audio processing.

In any radio transmission system, there is a finite maximum audio level the system can handle: AM has 100% modulation, FM has 75kHz deviation and DAB+ has 0dBFs. The transmission chain thus has one or more devices that automatically control the level of modulation so as not produce distortion, spectral irresponsibility, etc. These processors can add other "benefits" such as increasing perceived loudness, brightness, thump or whatever other attribute you wish to enhance.

On a practical level, they do correct errors by studio operators and cope with different listening environments. In extreme cases, they can produce "listener fatigue" by destroying dynamic range.

Typical processors these days work in the digital domain and will usually offer:

- Slow broadband AGC for "hand on a fader" level consistency over time.
- Group delay processing to remove asymmetry or correct transmitter deficiencies (more so for AM).
- Multi-band compression to enhance loudness and perhaps produce a "signature" sound.
- Fast peak limiting to handle momentary transients and further enhance loudness.
- Peak clipping for even more of the above.

Most audio processors can produce that loud, aggressive "wall of sound" result if that's what the station wants. While over-zealous processing can be unpleasant in itself, I suspect that it produces additional problems with DAB+ transmission.

It's conventional practice in AM transmission to use fairly severe treble boost (and hence compression) to counter the narrow IF bandwidth of most receivers. FM (in Australia) has to have the 50us pre-emphasis to match receiver de-emphasis, which amounts to over 14dB boost at 15kHz. Any attempt to brighten an FM transmission chain gets added on top of this, so the resulting high-frequency squash gets pretty ugly in terms of reduced headroom. But many digital processors sell themselves with these capabilities.

By contrast, DAB+ specifies no pre-emphasis at all, so the audio processor has no particular requirements apart from watching 0dBFs and enacting whatever aesthetic decisions the humans make.

My listening to DAB+ suggests that many stations are still processing their audio fairly hard. In particular, there can still be quite a lot of high frequency boost and compression – you want to be bright and stand out – that's conventional wisdom in commercial radio, at least. Just hard multi-band compression alone results in boosted high frequency levels with most content.

Greg Segal, GWS Audio Visual, Kew East, Vic.

Change of name for Australia Hears

Thank you to Joe Moldovan for his glowing letter in the Mailbag pages of the November 2011 issue, in response to Ross Tester's article about our DIY hearing aids (SILICON CHIP, July 2011). We were very chuffed to read the good news.

As a follow-up to this, I wish to inform your readers that *Australia Hears* has just changed its name and website to *Blamey & Saunders Hearing*. The name change was made in agreement with Australian Hearing Services, the Australian Government body assisting the community with hearing loss, to ensure that there is no confusion between the names "Australian Hearing" and "Australia Hears Pty Ltd", the former of which is protected by an Act of Parliament.

We are still very proudly Australian and our delivery of excellent customer service and terrific self-programmable hearing aids will continue unchanged. Merry Christmas readers and happy tinkering.

Dr Daniel Taft,
Chief Technology Officer,
Blamey & Saunders Hearing Pty Ltd (formerly Australia Hears Pty Ltd), East Melbourne, Vic.
www.blameysaunders.com.au

DAB+, DRM & FMeXtra options

I have read with interest the recent correspondence on digital radio. I have also been listening to the various DAB+ broadcasts in Canberra and during a visit to Sydney. It is useful getting local AM radio stations on DAB+ (ABC and commercial, interference-free), as AM radio suffers from too much interference these days where I live.

The 64kb/s stream is disappointing on 2CA, losing some life and detail from music. ABC local radio and Radio National is even lower at 48kb/s

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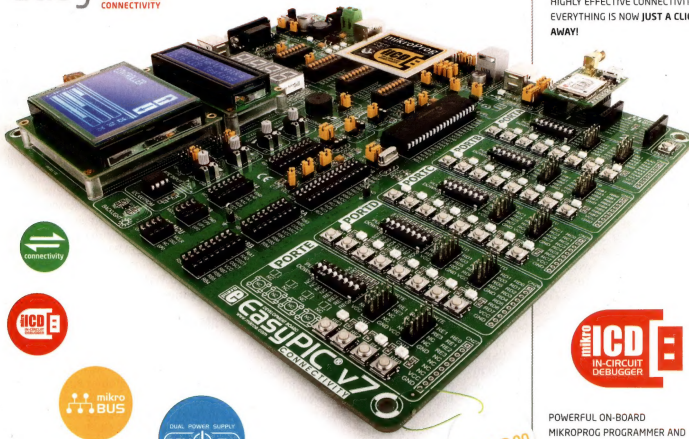

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Mailbag: continued

Nostalgic journey with Maximite

In June 2011 you printed my email about the Maximite computer and on reading Ian Finch's letter in the September 2011 issue, I felt inclined to update you. First, I did get my Maximite from Altronics, not long after the June 2011 issue came out.

Second, my direction has had to change and I don't plan on building an EEPROM programmer onto it or my new designs (PortaMite – styled like a hand-held game console or Protomite – a 100-pin chip with breadboard and SPI memory). My new direction is pretty much all software.

My Maximite went together quite readily and almost worked perfectly, first time. I say almost, because I have found that it rejects all of my cheaper (blue, Sandisk) SD cards. It is mostly fine with the higher end Ultra II and Extreme II. It also can reject folder names created on my PC (Lenovo, XP Pro), which I work around by creating folders on the Maximite.

The big thing I am doing with the Maximite is refreshing my skills in programming with old BASIC dialects and particularly, my passion for Prime number calculation. It does take almost three weeks to run the Sieve of Erastosthenes to 16,777,216 but hey, I didn't buy a Cray!

I am working to refine this program (after it finishes a run started at 23:47 on 28 August 2011), as it only needs to test against primes, not every odd number. I hope to make it smart enough to cope with planned shut-downs and restarts, maybe even unplanned ones. At present, it presents a huge challenge compared to GW-BASIC (GWB). GWB will save file data if you interrupt it; the Maximite doesn't.

Beyond that, my goal is do try and resurrect the old character-based games we used to play on microcomputers before the IBM PC. Having lost my original source books by David Ahl, I have found scans of them at **www.atariarchives.org** where you scroll down to "Basic Computer Games", "More Basic Computer Games", "Big Computer Games" and "Basic Computer Adventures." Plus I hope to include Eliza, Animals and even the true classic, Colossal Cave Adventure (which needs conversion from an ancient FORTRAN dialect).

To date, I have succeeded with Acey-Ducy (seemingly bug-free) from the first book. And I've typed in Amazing but got stuck with a coding error I haven't nutted out. I am quite happy for anyone who wants, to join in. They can email me at **totoaus@gmail.com**

David Morton,
Geeveston, Tas.

and Dig Jazz at 56kb/s. However in Canberra it is only a trial with limited channel capacity.

On a recent visit to Sydney I had a listen to some of the various digital radio services there and concluded that the 96kb/s stream of 2CH was about the lowest bit rate consistent with reasonable quality. 2UE is 128kb/s; as it mainly a talk and talk-back station it was more than adequate quality. I did a comparison between classical and jazz community station 2MBS on FM and 2MBS on DAB+ at 64kb/s. The was a "rounding off" of the sound and lack of some definition in the audio on DAB+, though the lack of reception artefacts such as multi-path was welcome.

What concerns me is that DAB+ seems only suitable for city-wide stations and then maybe requiring some in-fill transmitters due to terrain. There is the expense and complication of each station having to feed their digital stream into a common transmitter.

Contrast this with FMeXtra. ArtSound FM in Canberra ran some tests on this and I am told they found that the FMeXtra signal was of excellent quality; maybe better than FM. The advantage of FMeXtra is that it rides on the station's existing FM signal, allowing four high-quality stereo services on the station's existing transmitter. This would have seemed the better solution for many stations than DAB+, especially for low coverage suburban FM Community Radio Stations.

The recent announcement by the ACMA of DAB+ as the standard has permitted the possible inclusion of DRM30, which is transmitted along with existing AM transmissions from the broadcast band up to 30MHz shortwave, 4kHz below the centre carrier, and DRM+ which can be used on VHF frequencies, including the FM broadcast band.

One big problem is the viability of receivers, though I am sure one manufacturer was developing a chip for all digital radio standards. FMeXtra is used on some shortwave and a small number of FM stations in the USA. However, I think there is only one receiver available.

Australia, with both the low-coverage community and narrowcast stations and the big coverage AM regional stations, needs a wider ranging solution than just DAB+. Otherwise I wonder about the future of these services.

David Webb,
Fadden, ACT.

AM radio coverage is superior to FM

With reference to the discussion on DAB+ versus AM/FM in the Mailbag pages of the October 2011 issue, a factor overlooked was that AM uses ground wave propagation; it is not limited by line of sight.

VHF/UHF would require many repeaters to equal 50kW of AM. In a bush-fire repeaters can burn but AM is unaffected (with the transmitter in a safe area). There is no shadow behind hills etc, coverage is out to some 100km, and it's receivable on a cheap pocket radio.

Ron Rye,
Heidelberg, Vic.

Cassette recorder project not economic

I read with interest the September and October 2011 Mailbag letters calling for the development of a "cassette recorder equivalent" project. From the descriptions of the desired features I am sure that any project which matched these specifications would be very capable and would prove interesting for those who ended up building it.

Charging ahead for lightning protection

I read with interest your article on the "Lightning Detector" (SILICON CHIP, July 2011), having myself designed a "Thunderstorm Monitor" which was widely published in 2004. Your design works on the principle of detecting electromagnetic emissions, while mine worked on the principle of monitoring atmospheric charge – an advantage of the latter design being that no prior electromagnetic emissions are necessary for detection.

I was concerned, however, to note the ambiguity of your article with regard to the hazards of lightning. For instance: "Anything less than 1km (ie, 3s) should be regarded as getting very dangerous." In fact, if one is able see a flash, or hear a thunderclap, anywhere in one's environment, it is already too late to seek safety. The hazards of lightning should not be underestimated. As an example, it causes more deaths than hurricanes and tornadoes.

Having said this, I would propose an alternative approach: personal lightning protection. Ordinarily, atmospheric charge at the top of one's head is in the region of 180V-250V. This means that a human would "stand out electrically" above the ground at 180V-250V. Consider then that, during conditions conducive to a lightning strike, atmospheric charge at the top of one's head may be in the region of 9000-18000V. This means that a human would "stand out electrically" above the ground at 9000-18000V. Small wonder, then, that lightning seeks out, as an example, golfers on a golf course.

Theoretically, if one were to charge the body to 18kV, the potential at the top of one's head should equalise with the ground. Thus a person should become invisible to lightning seeking a target. From an electronic point of view, this should not be difficult to implement. And if the body were charged higher still, it should appear as a hole in the ground – from the point of view of lightning. The principle might also serve to protect structures or grazing animals.

Rev. Thomas Scarborough,
Cape Town, South Africa.

Comment: a most interesting letter. Mind you, even if you could charge yourself up to high voltage, we are not sure there would be much protection – we certainly would not want to rely on it.

In any case, we understand that at least some stock losses due to lightning are because of the high voltage gradients across the ground during a strike – the stock are electrocuted because of the voltage drop between their forelegs and hind legs.

I believe that it is still possible for hobbyist constructors to build very high quality equipment at a fraction of the price of equivalent commercial units (and learn lots along the way) but only for certain types of equipment. As time goes by, the equipment types for which this is possible changes. Common items featured as projects in years gone by (such as analog radios, TVs and oscilloscopes) dropped from the list years ago but that still leaves plenty of really useful niche

Mailbag: continued

New op amp fixed Milliohm Adaptor

I made the Millohm Adaptor (SILICON CHIP, February, 2010) and have experienced the same problem as did K. R. (Ask SILICON CHIP, April 2011). Until I made the adaptor, I was using a meter with an LM317T as a constant current source and a PM128 LCD panel meter. This gave quite good results but when I saw your adaptor I was impressed with the features of the design and constructed one.

Like K. R., calibration was straightforward, after doing the modification to get the zeroing correct. On both ranges, the adaptor gives good results with resistances towards full scale. For lower value resistances, the adaptor indicates a lower value than the actual resistance. This happens on both ranges.

For example, on the 10-ohm range, a resistor marked as 1Ω gives 0.835Ω on the adaptor. On a bench-top DMM it indicates 0.98Ω and on my old meter it indicates 0.99Ω. This is similar to the results noted by K. R. The error is similar on the 1-ohm range.

After much reading and measuring I came to the conclusion that there was a significant offset voltage at the output; up to 15mV at low resistances. With the input shorted to ground to do the Zero Set adjustment, the offset was 5mV. Eventually I bit the bullet and got a new AD623AN. This fixed all the problems. During the initial setting up or doing the modifications around the zero set circuit I may have shorted the output, so giving the strange results.

My experience may be useful to others with the same problem.

Geoff Smith,
Somerton Park, SA.

projects. In my view, a high-quality portable solid state recorder is another example of an item which is not worth developing as a project.

Anthony Mott (in the October 2011 issue) wrote that you "... can buy nifty little digital recorders at various consumer electronics vendors but they are not adequate for most tasks". If what you're after is a well-featured high-quality recorder then I completely agree. However, that is not to say that such recorders are unavailable. They're just not consumer units.

Features such as balanced inputs, high-quality on-board microphone and so on move you into the semi-professional and professional audio market, and here you will find a plethora of so-called solid state "field recorders". They vary in price according to the feature-set and ruggedness of the units but most tick all the boxes that correspondents have been requesting over the past few months. Most importantly, nearly every one offers the option to record using uncompressed PCM audio formats, so you don't have to put up with MP3 compression artefacts.

At the lower end of the market you have the likes of Zoom who make the H2, H4 and several other portable recorders. These are aimed more at musicians who want to easily record rehearsals, gigs and so on but they work great as general recorders too. Their all-plastic construction (with the exception of the metallic mic grille) isn't all that rugged but for the price – starting with street prices below $300 – they just can't be beaten.

In the mid-level market (prices of the order of $500-$2000) you have the likes of Marantz with their PMD series field recorders. They are more rugged (as you would expect) and sport a few more features of particular interest to professional recordists.

The top-end of the market is typified by the Nagra recorders, solid state descendants of the renowned tape-based recorders which have been used by field sound recordists for many decades. This group typically retails for quite a bit more than $2000 but has quality and features to match.

At the end of the day, you will get what you pay for but I suspect that even the entry-level recorders will pack far more features and greater

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One man's waste is another's convenience

I fully agree with your comment, at the conclusion of the September 2011 article on reducing your power bill, that "only energy that is being wasted can be saved".

But the devil is in the definition – one man's waste is another's convenience. You mentioned how stand-by appliances use power but are "hot-to-trot". Our hot-water cylinder isn't insulated but we use the cupboard to "air" slightly damp clothes – it's the only thing I'm not doing on my power company's "how-to-use-less list".

And you lead off with 2½ pages on swimming pool pumps. When were they ever a necessity of life? Turn it off and get to know your neighbours at the local council pool.

Other energy wasters spring to mind: clothes driers for apartments and houses on land too small to have a washing line; dishwashers used part-full; hot water circulators, for "instant" hot water; electric cars – a subject that's best left to another time . . .

Yes, there is a lot of power being used wastefully but only if the consumer has not consciously chosen to use it. Heaven forbid that government steps in and (over-)regulates power allocation.

Allen Reynolds,
Auckland, NZ.

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The existence of the "field recorder" market may well be of interest to Anthony Mott and others who have asked for a "cassette recorder equivalent" over the past few months.

Disclaimer: I purchased a Zoom H2 a number of years ago to replace a high-quality hand-held Walkman-style cassette-based recorder and have never looked back. I have no relationship with Zoom Corporation beyond being a satisfied customer. All companies mentioned in this letter are provided as typical examples only.

Jonathan Woithe,
Valley View, SA.

Electric bikes can be a legal minefield

I read the article in the October 2011 issue about converting a bicycle into an electric bike. I've been involved in both the technical and legal aspects of electric bikes for the last couple of years and have to say that the technical side is trivial compared to the tangle of barbed wire that is the law.

In NSW, the law is laid out in Vehicle Standards Information (VSI) 27, which is quite clear, with handy pictures to guide you but a minefield nonetheless. Have a look for yourself but the gist is that a bicycle assisted by a motor of up to 200W is a legal "power assisted pedal bicycle", which does not need to be registered.

There is also some commonsense stuff about a requirement that the motor not being easily modified for higher output. Anything not meeting those requirements is classed as a moped and is thus subject to the full weight of Australian standards, registration, rider licensing, etc.

The difficulty is that 200W electric motors do NOT put out 200W! That 200W is a continuous power rating

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and progressively overloading an electric motor will inevitably cause it to draw more current and hence more power. For example, a 180W motor that I tested had a peak output of some 350W – running at that power for very long would cause it to smoke but the key fact is that it put out over 200W.

I spoke to the top people in Canberra earlier this year and their final verdict is that the second a motor puts out anything over the legal 200W, it becomes illegal as a bicycle.

It gets worse though – there was a group who was trying to get a bicycle certified with a governor to limit the output but after a lot of work it was declared illegal because the governor could be removed, resulting in illegal power output.

The law can and does check electric bicycle output. A fellow was found riding his electric bike on the footpath in NSW (a no-no) and his bike was put onto a motorcycle dyno where it was found to peak at 650W. As far as I understand it, that means that he was riding an unregistered and uninsured vehicle, without a motorcycle license or approved helmet, and the vehicle was a prohibited import, liable to confiscation and destruction!

In my opinion, the law is an ass beyond belief and has managed to defend us from super-efficient electric vehicles for at least the last 10 years that I know of. It is nevertheless the law and one crosses it at one's own risk.

Rather than try to fight it, I think that the clever readers of this venerable periodical could put their minds to the problem and come up with a technical solution that thumbs its nose at such a ridiculous situation!

Nenad Stojadinovic,
Woden, ACT.

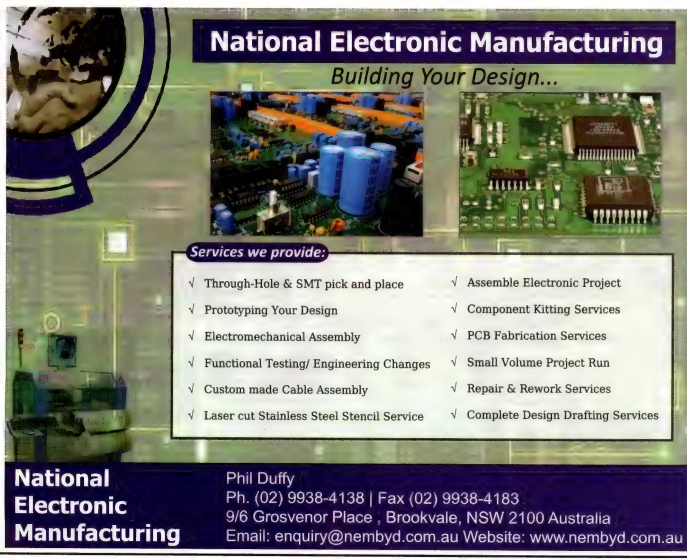
Poor soldering is quite apparent

I draw your attention to the photographs on pages 86-89 of the October 2011 issue, showing the PCB detail of the Hifi Stereo Headphone Amplifier.

To my horror, I noticed that the section of tinned copper wire meant to earth the volume potentiometer was not properly soldered! If you look closely, you can see that the solder blob has not "wetted" to the plated casing of the pot. Clumsy.

Gary Johnston,
Managing Director,
Jaycar Electronics.

Comment: despite appearances, it has been properly soldered. The passivation on those pots is difficult to remove and you need to remove quite a lot to get a "nice looking" joint.



Thousands of antennas... one radio telescope

The Square Kilometre Array

By Geoff Graham

By any standards the Murchison region of Western Australia is an empty place. There are no towns, few roads and the population density is just one person for every 300 square kilometres. But there is a sense of excitement in the air. A high speed optical fibre has been run into the heart of the region, large semi-trailers regularly arrive loaded with high-tech equipment and scientists have become regular visitors. What is happening?

Australia and New Zealand are engaged in a high stakes race that most people do not even know about. It is a race to host one of the largest scientific projects ever envisaged on the planet... the Square Kilometre Array.

The Square Kilometre Array (abbreviated to SKA) is an international initiative to build the largest radio telescope in the world.

The stakes are high. It will use technologies that have yet to be developed, will involve many countries from around the world and will cost billions of dollars.

The SKA consortium started with a list of four possible sites and has whittled that down to a short list of two; one in South Africa and the other in the Murchison region in Western Australia.

The Square Kilometre Array is a response to two of radio astronomy's great issues: resolution and sensitivity.

With an optical telescope you are dealing with light that has a wavelength of the order of 600 nanometres and it is relatively easy to construct mirrors and lenses that can reflect and focus these short wavelengths.

Radio telescopes

In a radio telescope the wavelengths are much longer and so the "mirrors" (reflecting dishes) need to be correspondingly larger. This and the need for sensitivity has led to an "arms race" in radio telescopes with dish sizes growing from the 76-metre dish of Jodrell Bank in the UK (1957) to the 305-metre dish used by the Arecibo Observatory in Puerto Rico (1963).

With increasing size came improved resolution and sensitivity but it came at a cost. The Arecibo telescope is so large that it had to be built onto the walls of a valley and its view of the sky is determined by that part of the Earth is pointing to any particular time.

Another way of addressing the size issue of radio telescopes is to use an array of smaller dishes and employ complex electronics and powerful computers which correlate the signals to simulate one large dish.

The Very Large Array in New Mexico (USA) uses this technique, with the individual dishes spread out by up to 36km. This gives it the resolution of a single, very large steerable dish. While this was a great advance, the sensitivity of the telescope was still limited by the relatively small number of dishes and the resulting small collecting area.

The Square Kilometre Array

The Square Kilometre Array intends to get around this issue by using thousands of dishes with a total collecting area of one square kilometre; hence the name, Square Kilometre Array.

The majority of the dishes will be concentrated in one area but some will be up to five thousand kilometres away. So the array will have a resolution implied by the 5000km

Artist's impression of dishes that will make up the SKA radio telescope. Each dish is approximately 15m in diameter. *Courtesy Swinburne Astronomy Productions/SKA Program Development Office*

Potential SKA array station placement in Australia and New Zealand indicating the 5,500km 'baseline' or maximum distance between the array stations. ***Image courtesy CSIRO***

baseline but a sensitivity derived from its one square kilometre of collecting area.

The Australian and New Zealand bid for the SKA envisages about 3000 dishes centred in the Murchison with some dishes scattered as far away as the east coast of Australia and New Zealand, giving that huge baseline.

The signals from all these antennas will be correlated and reduced using massive super-computers, giving scientists a detailed and far-reaching image of the sky at radio frequencies.

One of many technical problems that must be addressed is that current supercomputers are simply not capable of processing the enormous amount of data involved. But the SKA is planned to become fully operational in about 2024 and it is anticipated that by then, the evolution of electronics and computer technology will have reached the level where it will be able to handle the data stream.

As an illustration of the technology involved it has been estimated that the combined data stream from the 3,000 dishes will be thousands of Terabits per second, equivalent to many times the world's current internet traffic rate.

So this is a project that cannot work today but is critically dependent on the relentless march of technical innovation. It's a huge gamble, although some would say, a safe gamble!

However the rewards will be great. The SKA will be 50 times more sensitive and be able to survey the sky 10,000 times faster than any imaging radio telescope array currently running.

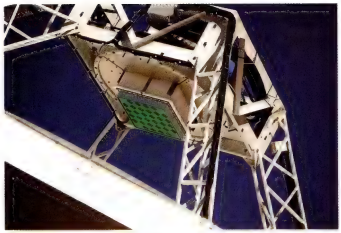
Its high sensitivity means that it will be able to probe earlier in time towards the big bang and observe the very first black holes, stars and galaxies that shaped the development of the universe.

Other key projects include investigating the evolution of galaxies, testing theories related to cosmology and dark energy and answering questions related to the origin and evolution of cosmic magnetism. Astronomers also want to use the SKA to search for life and other planets outside our solar system and conduct tests of general relativity using pulsars and black holes.

The SKA project

The SKA project is a collaboration of 20 countries, comprising Australia, Brazil, Canada, China, France, Germany, India, Italy, Japan, Korea, The Netherlands, New Zealand, Poland, Portugal, Russia, South Africa, Spain, Sweden, United Kingdom and the United States.

It is difficult to be precise on the details of the SKA as the design phase has only just started but it has been es-



A close look at CSIRO's ASKAP prototype phased array feed which was installed on the Parkes Testbed Facility in July 2008. ***Photo: David McClenaghan, CSIRO.***

timated that the overall cost will be in the region of $2.5 billion. Much of that money will be spent in the contributing countries who will be building the technology – it will provide an extra powerful boost for the host country's technical and scientific capabilities.

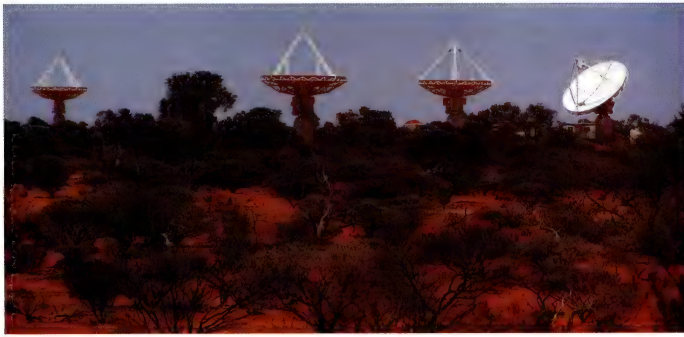
It is one of a very few multi-billion dollar science projects in the world. Another often-quoted example is the Large Hadron Collider at CERN, situated on the border of France and Switzerland.

Currently the headquarters for the SKA project has been selected (Jodrell Bank, UK) and some initial funding has been allocated. Also some progress has been made towards selecting the site, either in South Africa or the Murchison region in Western Australia.

Key dates include the design phase starting in 2013-2015, initial construction in 2016, the first astronomical observations in 2020 and full operation in 2024.

For Australia and New Zealand, the most anticipated event is the selection of the country that will host the SKA.

Assembly of CSIRO's first ASKAP antenna at the Murchison Radio-astronomy Observatory. ***Photo: Carole Jackson, CSIRO.***



Four of CSIRO's new ASKAP antennas at the Murchison Radio-astronomy Observatory, October 2010. ***Photo: Graham Allen, CSIRO.***

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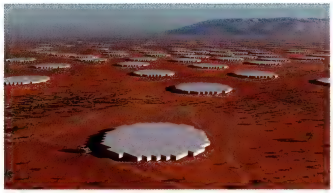


Although the design of the SKA has not been finalised it will probably involve more than just the traditional radio telescope dishes. This is an artist's impression of the SKA's proposed dense aperture array antennas. These will operate at mid-frequencies and are closely packed antennas arranged in tiles within stations. The size of the dense aperture array stations is likely to be about 60m diameter. *Courtesy Swinburne Astronomy Productions/ SKA Program Development Office*

This announcement will be made in late February 2012, just two months away.

Government support

The Australian and New Zealand governments were quick to provide high level support for the bid to host the SKA. In particular, Australia has pulled out all stops to demonstrate that the country has the technical capability and the will to host the SKA.

To start with the Murchison region has been identified as the best site for the SKA and to support this proposal the Australian government has purchased a pastoral property, Boolardy Station.

Typical of the properties in the area, at 3,467 square kilometres it is one third larger than the Australian Capital Territory.

In this arid climate the number of animals must be restricted to give the natural vegetation time to regenerate after being grazed on, so Boolardy runs a small number of cattle which roam far and wide through the natural bush with hardly any human contact.

The government has since leased the grazing rights back to the original owners so that they could continue doing that. As a result there could well be cattle grazing in the shade of the dishes but this is OK; they do not emit radio noise!

Murchison Radio Observatory

Part of Boolardy has been excised and named the Murchison Radio Observatory (MRO) and will be the core site for the SKA should it come to Australia.

In addition, the Australian Communications and Media Authority have established a "radio quiet zone" band plan which outlines the purposes for which the radio spectrum may be used within 150km of the MRO.

This seeks to manage all frequencies from 70MHz to 25.25GHz, with an inner zone of 70km where the requirements of radio astronomy will have precedence over other activities.

The most potent demonstration of Australia's determination is the funding of the CSIRO Australian Square Kilometre Array Pathfinder project (abbreviated to ASKAP). This project involves much of the technology required for the SKA but on a smaller scale.

This includes 36 dishes, a high-speed fibre network and a supercomputer facility in Perth.

The ASKAP is currently under construction at the Murchison Radio Observatory and should become operational in 2013.

This is why the small population in the Murchison are seeing so much activity. The high-speed fibre optic data link is required to connect the site to the rest of Australia and the large semi-trailers are carrying the components to build the telescope.

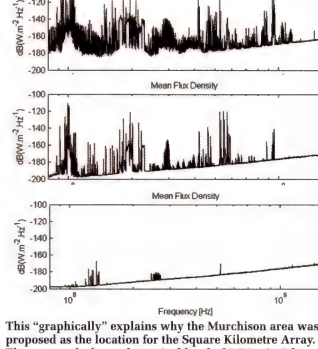
Why the Murchison?

The primary reason for choosing the Murchison region is the very low level of radio noise in the area, mostly due to the small number of people living there. With a population density of less than one person for every 300 square kilometres and no radio stations, no mobile phone towers or most other sources of radio pollution, it is a very quiet place especially as far as the radio spectrum is concerned.

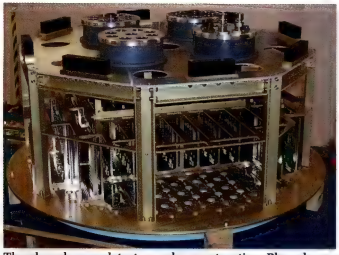
There is no town or city within the area and the nearest reasonable-sized town (Geraldton) is over 300km away. It does have some disadvantages though. It is hot and dry and the remoteness is a logistical challenge but to the scientists that is nothing when compared to the advantages of a region with almost total radio silence.

The proposed site of the SKA lies in the Murchison Shire which is in Western Australia, about 738km north of Perth and 250km inland.

This shire is unique in Australia as it is the only local government body that has no town or city or even a large



This "graphically" explains why the Murchison area was proposed as the location for the Square Kilometre Array. The top graph shows the typical level of RF "noise" for Sydney; the centre graph is for Narrabri (where the Australia Telescope Compact Array is located) and the bottom graph is for the Murchison Shire. *Courtesy Ant Schinckel, CSIRO.*



The phased array detector under construction. Phased array feeds will be used by ASKAP's 36 antennas to detect and amplify faint radio waves, a development being pioneered the CSIRO for the ASKAP telescope.
Both photos: Courtesy Ant Schinckel, CSIRO

The completed ASKA phased array detector, the heart of the telescope. A phased array feed array acts as a multiple pixel sensor and is much faster than conventional telescope sensors which can see only one pixel.

settlement within its boundaries.

The Murchison Shire is not small; it is 50,000 square kilometres or a little bigger than the Netherlands. However its total population is only 100 to 160 (estimates vary) with just 29 pastoral properties as the major ratepayers. Imagine, the Netherlands with only 29 farms!

The shire has its offices and maintenance depot located in the Murchison Settlement (population about 25) which is also the only place to buy petrol in the shire.

Most telling of all, there is no pub or hotel anywhere in the shire.

As well as being the proposed site for the SKA, the Murchison Radio Observatory will also host a number of other radio astronomy projects. These include the SKA pathfinder project (ASKAP) and the $30 million Murchison Wide Field Array project developed by Australian, Indian and American scientists. So this purchase will not go to waste if Australia loses its bid to host the SKA.

The ASKAP project

The Australian Square Kilometre Array Pathfinder (ASKAP) project is being driven by the CSIRO and is a very large project in its own right.

When completed it will be the world's most powerful survey radio telescope by a factor of 10. While it will be a potent scientific tool it will also demonstrate that Australia has the capacity to host a mega science project such as the SKA and will provide a base for training our future engineers and scientists.

The ASKAP telescope will generate 72 Terabits of raw data every second. On-site processing will reduce that to 40Gb/s which will be transferred to a new supercomputer facility in the suburbs of Perth which in turn will reduce the data volume to the equivalent of one DVD per second; still an awful lot! The SKA is expected to generate many thousand times this data rate.
Courtesy Ant Schinckel, CSIRO.

The ASKAP telescope will consist of 36 steerable dishes each 12 metres in diameter linked to a telescope in New Zealand to give an extended baseline.

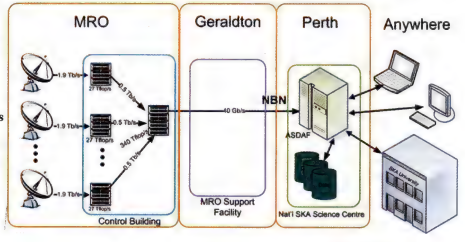
The estimated cost is over $150 million; a lot of money for a pure science project in Australia. Normally the scarce research dollars are reserved for solving practical problems in agriculture and the like.

Each dish will have a completely new and unique radio "camera" that will be able to record multiple points in the sky. A normal radio telescope has all the radio energy focused onto one detector so it can be thought of as recording a single "pixel" of an image of the sky.

By contrast, the ASKAP dishes will have 188 active elements in an array, so they will be able to record multiple "pixels" giving the telescope the ability to simultaneously sample large areas of the sky much faster than a conventional radio telescope.

This Phased Array Feed (PAF), as it is called, comprises a checkerboard phased array, analog and digital signal processing systems and the associated support systems required to run this unique receiver. It was developed in Australia by the CSIRO for ASKAP.

It, along with the entire ASKAP project, is a good demonstration to the rest of the world of the level of Australia's capabilities in building and designing the high-tech com-



"Mr WiFi"

One scientist who was involved in the design of the ASKAP telescope is Dr John O'Sullivan. He helped design the unique multiple pixel sensor used in the telescope.

Dr O'Sullivan is also noted as the lead scientist involved in the development of the ubiquitous wireless networking technology IEEE 802.11a – also known as WiFi.

As most of our readers know, WiFi has stormed the consumer world and is used all types of gadgets from mobile phones to cameras and much more.

While researching this story SILICON CHIP had a rare opportunity to meet and talk with Dr O'Sullivan about the development of WiFi. It makes an interesting tale.

The story began in the early 1980s as scientists were using more and more exotic technology in the pursuit of the faint signals from radio telescopes. During this period, one technology that became pivotal was the implementation of Fast Fourier Transform (FFT) processing in hardware.

At about the same time, the then new CSIRO Chief of Radiophysics, Dr Bob Frater, set a challenge to the scientists in the division: to develop some commercial application from these technologies.

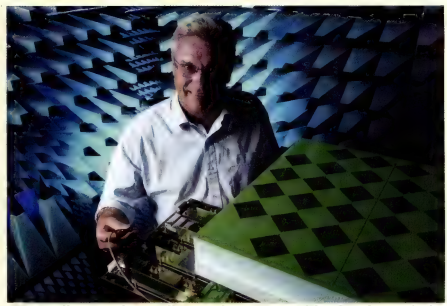
As Dr O'Sullivan simply put it "there was a need to network our laptops" so the CSIRO formed a team of scientists to focus on just that.

Their target was way beyond anything then available: a 100Mb/s wireless local area network for offices and meeting rooms.

The technology they used (later to become WiFi) was based on multiple carriers, all transmitting part of the data stream and is called OFDM (Orthogonal Frequency-Division Multiplexing).

The team built on the idea that FFT technology could be used to divide up the spectrum in such a way that the severe and complex reflections found inside buildings could be compensated for at the receiver.

The development effort involved many CSIRO scientists in association with Macquarie University and led to an Australian patent in 1992 and a USA patent in 1995.



CSIRO Fellow, Dr John O'Sullivan and a prototype of the phased array feed being developed for ASKAP. Dr O'Sullivan also led the CSIRO team that developed 802.11a or WiFi ***Photo: Chris Walsh, Patrick Jones Photographic Studio***

These patents covered the technology behind the wireless transmission, not the idea of wireless networking itself as believed by many people.

With more development and an overseas promotional campaign, OFDM was eventually adopted as the basis of the IEEE 802.11a standard in 1999.

The early implementations of WiFi were hampered by the level of semiconductor technology available at the time, as the digital processing power required was bulky and consumed a lot of power. Now everything can be packed into a few integrated circuits using very little power.

This is another example of a technology which needed the ongoing march of semiconductor development to make it a practical reality.

From 2000 to 2009 WiFi saw an enormous take-up but most vendors implementing the standard were ignoring the CSIRO's patents.

The result was increasing litigation against companies such as 3Com, Asus, Belkin, D-Link, Fujitsu and Toshiba.

In response, the industry formed a single heavyweight group including HP, Apple, Intel, Dell, Microsoft and Netgear in an effort to quash the CSIRO's claims.

Fighting this case was a high stakes gamble undertaken in foreign courts with legal costs running into many tens of millions.

Full credit is due to the tenacity of the CSIRO in pursuing this strategy as a loss would have been very expensive.

As most Australians know, the CSIRO did have a win in 2009, with a number of manufactures agreeing to pay royalties.

Bolstered by this the CSIRO is now pursuing other companies and is steadily reaching agreement on royalties.

The terms of the agreements are confidential but they are expected to bring hundreds of millions of dollars to the CSIRO who will invest it in new and innovative projects within Australia.

Dr O'Sullivan has since retired and has been made a CSIRO Fellow – a great honour.

To date, over one billion WiFi chipsets have been manufactured.

When asked if he was surprised by this success, Dr O'Sullivan replied "Well not completely. We thought it could be big but I am blown away by how big."

"Nowadays when I see the amazing number of portable and mobile devices I have to think that even my rosiest predictions have been exceeded!"

If you want to know what it is like driving to the Murchison SKA site, staring at this photograph for four hours is a fair approximation – but you will still miss out on the bumps, heat and the dust. *Photo credit: Paul Bourke and Jonathan Knispel. Supported by WASP (UWA), iVEC, ICRAR, and CSIRO.*

ponents required for today's radio telescopes.

ASKAP technologies

It is not possible to talk at length about the technical details of the SKA because design decisions and funding arrangements are still being made. It is not even certain what antennas and frequencies will be included in the final design and anyway, there will undoubtedly be changes in direction as the project progresses. It is much easier to talk about the technology being used in the ASKAP project as that is already underway.

Currently the ASKAP project has installed nine dishes in the Murchison, with another in Warkworth, New Zealand to give a long baseline of 5,500 kilometres. When finished, the telescope will display an amazing array of technologies, mostly developed in Australia.

The data stream starts with the 188 pixel sensors at the focal point of each telescope. These will produce an enormous 1.9 Terabits/second resulting in a total data stream of 72 Terabits/second from all 36 dishes. To put this into perspective, it is estimated that the world's current total internet traffic is only 20 Terabits/second. This is for the ASKAP project alone, the SKA telescope will generate more than a thousand times this rate.

The data stream from each telescope is carried via an 18-fibre optical ribbon cable to a rack of equipment called a Beamformer, with one of these for each telescope. The output of each of these goes to more electronics which correlate and further reduce the data streams.

The processing requirements are enormous with one Peta operations per second (that is one thousand million million operations per second) needed to reduce the total data stream to 40Gb/s.

This is still a very high data rate and it will be piped via fibre cable to Perth for processing.

The federal government has made a grant of $80 million to build a supercomputer facility in the suburbs of Perth to process this data stream. The facility will be known as the Pawsey High Performance Computing Centre for SKA Science and it will rival supercomputer facilities overseas. Its starting capacity will be 100 teraflops, later rising to one petaflop as demand increases (a teraflop is one million million floating point calculations per second and a petaflop is a thousand teraflops).

After this processing effort, the data stream will have been reduced to the equivalent of one DVD every two seconds. This data will be stored in disk arrays at the Pawsey facility for later retrieval and analysis by researchers across the world.

Remember, this is just for the Australia's pathfinder telescope (ASKAP). The amount of data from the Square Kilometre Array will be many, many times this.

SKA site selection

As mentioned before, the competition for hosting the SKA is between South Africa and Australia/New Zealand. South Africa is also pulling out all the stops in an effort to attract the project. It has proposed the Karoo Desert in the Northern Cape as the preferred site for the SKA and has joined in partnership with eight neighbouring countries in its bid.

Not to be outdone in proving its capabilities, South Africa has proposed the MeerKAT, a 64-dish array that it claims will be the "largest and most sensitive radio telescope in the southern hemisphere until the SKA is completed."

This is an enormous investment for the country; the money allocated to their overall SKA bid is many times the current annual budget of the country's main research organisation, the NRF, and a significant component in the nation's finances.

In conducting this international competition the international SKA project is also striving for a win/win outcome for all participants.

An important feature of this contest is that both telescopes and the SKA will have differing characteristics, so none will be made directly redundant when future decisions are made. Regardless, there is still a lot of money being invested in this area of science.

The two countries made their final submissions to the project's site selection committee in September and now they have a nail biting wait for the decision. An independent SKA Science Advisory Committee will evaluate the bid documents which represent eight years of work and announce the decision in late February 2012.

So stay tuned for the big announcement.

STEADICAM®
Camera Stabilizing Systems

TAKING THE BUMPS OUT OF THE MOVIES

Part Two – by Barrie Smith

Seemingly unable to stop inventing more technology, Garrett Brown developed Steadicam® into more and more models. He then came up with radical ways of moving a camera above and across a sports field, down into a pool as a diver descends and tracking with swimmers as they move from one end of the pool to the other.

These days there seems to be a Steadicam for almost every need, user and budget.

Way down the bottom of the list is the Merlin model that is tailored for camcorders that weigh between 200g and 2.2kg.

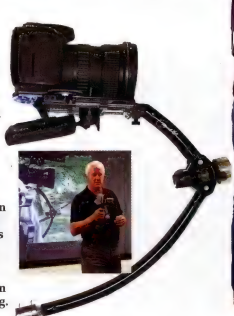
Shaped as a hinged, curved tube that weighs less than a can of Coke, Merlin can be handheld or attached to a vest. It is priced at around $1000.

Steadicam Pilot resembles a 'junior' Steadicam in its setup and appearance, based around the vest, iso-elastic arm and sled. It can carry a camera weighing between 900g and 4.5kg.

Another current model is one that Brown admits to thinking about in his early inventive beginnings. Steadicam Tango is a novelty in that, although based on the vest, arm and sled, the visible 'extra' is a jib arm that can rise from floor level to ceiling height. It's also able to make 360° pans with ±90° tilts all around. Camera weight range: 2.3 - 11kg.

Amazingly, there is even a budget Steadicam made for mobile phones that shoot video. Amateur camcorders? Maybe soon. Price: $US179.

The top models are the Ultra 2 and Ultra 2c, used by high end operators around the



To satisfy the need for a low cost stabiliser, Garrett Brown came up with the Merlin model, suitable for camcorders that weigh between 200g and 2.2kg. If fitted, the camera's internal stabiliser must be switched off as it can introduce delays in panning and tilting.

Steadicam Pilot incorporates the vest, iso-elastic arm and sled. It can carry a camera weighing between 900g and 4.5kg.

Top of the Steadicam range models are the Ultra 2 and Ultra 2c, which can support 5.4-31.7kg of camera.

world. They can carry 5.4 to 31.7kg of camera. Price: around $US66,000 with "all the bells and whistles."

Video at: **www.lemac.com.au/video/Steadicam.mov**

It seems the sky is the limit for extensions of the Steadicam principle as the camera can now soar above sports grounds and dive deep into Olympic pools.

SkyCam

According to one of his Australian associates "Garrett just can't stop inventing!"

Having totted up 50 patents worldwide for camera-associated inventions, devices like Steadicam, MobyCam, DiveCam, MoleCam, a new creation, SkyCam, earned him a 2005 Academy Award nomination. As with Steadicam, the idea for SkyCam was born on a film set.

During the shooting of the Little House on the Prairie TV series, Brown had the idea of a camera that could fly high above the action and move freely in a large three dimensional space.

So it was in 1984, the first use of aerial cable technology for motion pictures was seen, on the set of Birdy, a movie about a young Vietnam veteran who returns home obsessed with birds.

SkyCam is now a commonplace element in any sports coverage, first appearing in February for NBC's 2001 football coverage.

In operation, SkyCam resembles a flying Steadicam, able to support a stabilised camera, thanks to a cable-rigged support. Whereas Steadicam is limited by the movement of the human operator, the range of SkyCam's movement seems boundless.

The crew is a SkyCam pilot plus a camera operator and assistants. The pilot moves the rig through space, as the operator moves the camera on its remote head. They sit side by side and work closely together.

Three components drive SkyCam: the central computer control, the spar (or central support and counterbalanced camera column) and the reel (motor drive and cables). These components are linked through the use of a highly complex fibre optic network. Each of the three parts works in tandem to move the supported camera to virtually any location and at any angle. It is the only stabilised camera system that can unobtrusively fly anywhere in a defined three-dimensional space.

SkyCam rides on four cables. These are made from a braided Kevlar-jacketed single mode optical fibre with conductive copper elements and capable of supporting 270kg.

Each is attached through a ring at the top of a tall tower or mounting platform of some kind, up in the air. Basically, the higher you can mount the four wires and farther from each other you can place them, the larger the three dimensional space it can work in.

Each cable carries fibre-optic signalling from the camera operator. The SkyCam pilot operates the spooling out and taking up of each. The degree of slack and take up is what determines the height of SkyCam, with a computer ensuring they stay locked together.

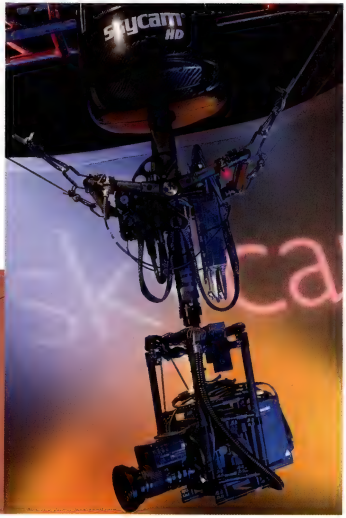
Each reel is a cable spool with 3.4kW motor and disc brake with its own computer, capable of .01 inch positioning resolution.

The camera's view itself is operated by remote head technology, handling focus, lens aperture and zoom; the link is

(Inset): Steadicam Tango monitor.

Steadicam Tango has a jib arm that cranes from floor to ceiling, making it the near-perfect production tool.

SkyCam resembles a flying Steadicam, able to support a stabilised camera, thanks to a cable-rigged support. The original patents have now expired.



by radio and an auto-ranging dish mounted near the top of an arena.

It is driven by a Windows XP computer that provides camera flight and video control and obstacle avoidance.

SkyCam was acquired by Winnercomm, Inc in 2004 and was then taken over by the parent company of the Outdoor Channel in 2009.

"SkyCam" is a trademarked name, and properly refers to one company and their equipment. However, with the expiry of the original patents, other companies have entered the market and the term is mistakenly used as a generic reference for any cable-controlled camera system. Fox Sports refers to their system as the DLP Ultimate Picture Cam.

SkyCam and systems like it have been in limited use since the mid 1980s when the technology was first patented but until the mid 1990s, progress was slow due to limitations in computer and servo motor technology.

All SkyCam patents have now expired, except one "quite valuable one" from 2000. There are about "half a dozen clones" scattered around the globe.

Watch the demo at **www.skycam.tv/folders.asp?action=display&record=3**

MobyCam

The world saw MobyCam splash into the pool at the Barcelona Olympics in 1992.

Steadicam Smoothee... a budget Steadicam made for the rest of us!

Enclosing a video camera, the 60cm long submarine housing travels between lanes four and five (closest to the top-seeded swimmers) on the black line at the bottom of the pool. The camera's progress is controlled by a mechanical pulley system. According to Brown, this kept the system simple and less likely to startle any "jumpy electrical inspectors" that might have kept MobyCam out

The Inventive Mr Brown

Meeting Garrett Brown at Sydney SMPTE, I asked him why he seems to have an almost compulsive need to invent.

"Well it's a serial issue, a serial problem. It comes up because I'm in the habit of understanding that if you want something, the primary inventive act is discovering something that's missing. If you can take for granted that something's missing that you want, the act of inventing something is actually pretty joyful.

It's the follow up that can get painful. But the act of inventing something frequently isn't as difficult as you'd imagine.

In some cases it's absurdly easy. The real trick is not skidding right on by. Let me show you an invention that I lug around with me that's the perfect example.

I love to invent personal things. My life is full of stuff that are one of a kind.

Now and then I need reading glasses if I'm in a dark restaurant. I hate lugging a glasses case around just to have reading glasses. So I decided I wanted my reading glasses in my wallet.

So I came up with this item and paid a jeweller to build this thing. So I have it with me all the time. It slips into my wallet and I've got very comfortable reading glasses and they do the job."

Once you've invented something, you've made a sample. Stateside or in Australia what are the problems of taking it to a patent stage?

"Stateside there appeared recently a thing called the Provisional Patent that can be as primitive as you want. It's the equivalent of the old game when we were kids. The folklore was that if you drew or wrote it up and you linked drawings and described it, then you mailed it to yourself, registered mail, you had at least established a date, which is a very imprecise process.

The patent office's Provisional Patent is more or less the same thing: you write it up and illustrate it as well as you can and file one. I've fallen into the habit of doing that and I believe there are international things that are similar.

So what you get is a year from that date. That establishes your date for whatever is in that package. A year later you have to file a regular patent or give it up. But at least it gives you a year to fuss with it and see if it's valuable.

I have been doing this long enough that I can pretty much do these myself, then hand them over to my long time attorneys and they just file them.

With all my Steadicam stuff we almost always do a provisional patent. And that's not terribly frightening, so I would recommend to anybody who has the bug to invent and they think it's 'date sensitive', if they want to control the date.

Humans are always inventing stuff. If it's in the wind somebody will come up with it. But I don't even bother searching them. I just control the date, then decide how valuable it is, then if the real date comes around a year later, you have to file it internationally and the whole bit.

And it is an enormous pain in the ass – patents. The US patent laws are under attack by businesses because they want it less inventor-friendly and more business-friendly. The laws are about to change. It's a

MobyCam is a 60cm long submarine housing that encloses a video camera and travels at the bottom of a competition swimming pool.

of the pool in Spain. As operator, Brown estimates he drove it 30km in Barcelona.

To see a MobyCam video go to **www.youtube.com/watch?v=MSAG861sr2A**

DiveCam

This device appeared in 1996 at the Atlanta Olympic Games.

It's an air-filled tube carrying a wide-angle lens camera which rides up and down on rails, pulled along by a wire and a pulley. Camera tilt is controlled remotely as it drops and the entire tube can be panned, both actions handled by the operator's joystick.

At the exact moment the diver leaves the board, an operator releases a wire, allowing the camera to drop. Thanks to gravity, both reach the water at the same time, traveling at approximately 40km/h, to deliver viewers a side view of the diver hitting the water. The camera is also remotely controllable to pan up or down slightly.

The operator watches the pelvis of the swimmer on a monitor. No other body part will do: there's no point in watching the head or the legs, as they're moving too quickly, depending on the dive being performed.

You can see a demo at **www.youtube.com/watch?v=DDped9n5_vk**

First seen in 1996 in Atlanta, Divecam tracks the path of a high diver plunging into the pool, traveling at approximately 40 km/h.

Feeling the need for reading spectacles that he can carry in his wallet, Brown came up with his version of a pincenez. He admits to hating the need to lug a glasses case around "just to have reading glasses. So I decided I wanted my reading glasses in my wallet."

hideous situation for a lone inventor. I have 50-60 patents. Some of them have expired. The original patents on the Steadicam and the SkyCam have all expired. Which is a shock.

You can't renew a patent but all the improvements you've made are patentable. So people are free to make the original primitive Steadicam. There are 40 of those in the world. But they're not free to make anything based on our improvements. And those we go after in countries where we have taken out those patents.

When I got my first patent, which was issued in 1977, for a Steadicam, I looked at the expiration (sic) date and I thought to myself, this will run until I'm 53. I'll probably be dead by then!

Well the date came up and I was very much alive and very shocked to see that thing expire. But that's the way the system works. You get your monopoly briefly."

What are the challenges in taking to the next step? To make a model and then go to manufacture?

"First of all, you rely on the inventive quality of the idea. If it's really invented, which means you have some property in that. We call it laughingly 'intellectual property'. And if the idea is valuable.

Is what you wanted valuable to somebody else? If you're inventing because you want one, that's a brilliant motive. And frankly if you want it, it's statistically likely there are lots of other people who want it.

But don't invent for money because that's a very slippery slope. If you imagine somebody else might want it but you don't necessarily want it, you're in big trouble.

Then watch out of course for all the predatory people who lurk around looking for opportunities. You'll see ads 'Let us market your invention', they'll tell you. Most of those, if not scams, are very unimpressive in terms of results.

If I were using the glasses for an example I would take that to manufacturers and try and find who is the friendliest soul who makes something closest to what you have come up with and what manufacturer would benefit from making this.

And then make a frontal assault on these guys. And the first thing they're going to say is 'No we're not interested.'

Or they want you to sign a non-disclosure agreement to prevent them from being sued if they do anything that may be similar. In some cases you have no choice but to sign it. But the second part of this package is that you have to be willing to spend a little dough. If inventing is on your mind, think of it as a hobby.

If your hobby was antique cars you'd spend money on it. If your hobby was fishing you'd spend money on it. But people are astoundingly reluctant to spend their own dough on an invention.

So you should spend money to get the prototype built well. A machinist is your best friend. You come in with a sketch and he'll build you something.

File a Provisional Patent. One step at a time. But spend your own dough on it. That's a sign of how serious you are.

Inventing is actually a lovely hobby. Seriously it is. If you start to populate your life ... my boat, everything is full of one of a kind stuff. It's really fun.

So you have the joy of owning it, whatever it is and you may have the prospect of making some money.

But do it in that order: own one first."

By NICHOLAS VINEN

Digital Audio Delay

. . . brings the sound and picture into perfect "lip sync"

Do you have a large plasma or LCD TV set and a home-theatre system? If so, you may have problems with sound and picture synchronisation (lip-sync). This Digital Audio Delay unit allows you to get the picture and audio perfectly matched.

LIP SYNC PROBLEMS can occur because modern TVs do a lot of video processing before the signal gets to the screen. Some sets (usually 100Hz or 200Hz types) can delay the picture by several hundred milliseconds. If you're using the TV's internal speakers, it will delay the sound by an appropriate amount so that they match but if you're using external speakers for better sound quality, this won't necessarily be the case.

Synchronisation problems are usually evident if you're connecting a DVD/Blu-ray player to the TV using a component video or composite video cable (ie, an analog connection) and feeding the sound direct to your home-theatre system. Sound sync problems can also occur with earlier HDMI systems but note that the HDMI 1.3 standard introduced automatic audio synchronisation to solve this problem.

Some DVD/Blu-ray players, home-theatre amplifiers and set-top boxes also have built-in audio delays but they sometimes don't provide a long enough delay or a fine enough adjustment to get the synchronisation just right. By contrast, this unit provides

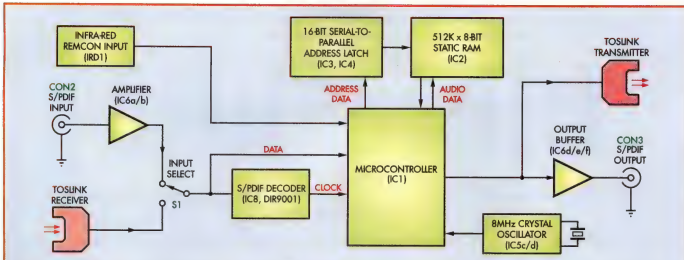


Fig.1: block diagram of the Digital Audio Delay. The incoming audio signal comes in either via coax to CON2 (and is then amplified) or is fed in via a fibre optic cable (TOSLINK). S1 selects between the two. IC8 recovers the clock signal and then the data and clock pass to microcontroller IC1. This buffers the audio in external SRAM IC2, with IC3 & IC4 used to select the storage address. The delayed audio is then simultaneously output via a TOSLINK transmitter and buffered RCA coax output (CON3). The crystal oscillator is used by IC1 to generate its instruction clock.

an adjustable delay from 20-1500ms in 10ms steps. It can handle Dolby Digital (AC3), Digital Theatre System (DTS) and linear PCM audio with a sampling rate of up to 48kHz. That covers most video recording media and broadcasts.

The unit can accept either an S/PDIF or TOSLINK digital audio input and because the delay is done digitally, it won't affect sound quality. You set the delay once using a universal infrared remote control and it remembers it from then on. The delay can be temporarily "defeated" (switched off) using the remote control when it isn't required (by pressing the mute button).

It wasn't possible for us to check it with all available multi-channel audio formats (there are quite a few) but most should work. The main restriction is the data bit rate; our design can handle up to 2.3Mbit/s. For example, we haven't tried it with Dolby Digital Plus or DTS-ES but they should be within its capabilities (depending on the exact encoding the player uses).

In reality, the upper limit is actually higher than 2.3Mbit/s but **note that the unit is not fast enough to handle 96kHz linear PCM** (eg, on DVD audio discs) which is over 4Mbits/s.

Operating principle

Digital audio from CD, DVD and Blu-ray players is transmitted using a protocol called S/PDIF, for Sony/Philips Digital Interconnect Format. The optical version, developed by Toshiba, is called TOSLINK (see the accompanying panel for a detailed description of the S/PDIF format).

This circuit is partly based on previously published audio projects, the most recent being the SportSync (May 2011). However, that project delayed an audio analog signal by using a micro to digitise it, then delaying the digitised signal and converting it back to analog audio using the micro's internal digital-to-analog converter. However, we cannot use the same method here because we are delaying a digital audio stream – see Fig.1.

The problem here is that, ideally, we need to delay the raw S/PDIF stream to preserve it in its entirety. But virtually all S/PDIF receiver ICs split the raw data into separate audio and data streams, which appear at pins 12 & 15-18 in the case of the Texas

The unit can accept either an S/PDIF (coax) or TOSLINK digital audio input, with a slide switch used to select between them. The delayed signal is then fed to a home-theatre amplifier or to a stereo DAC (digital-to-analog converter) to drive a conventional hifi audio amplifier.

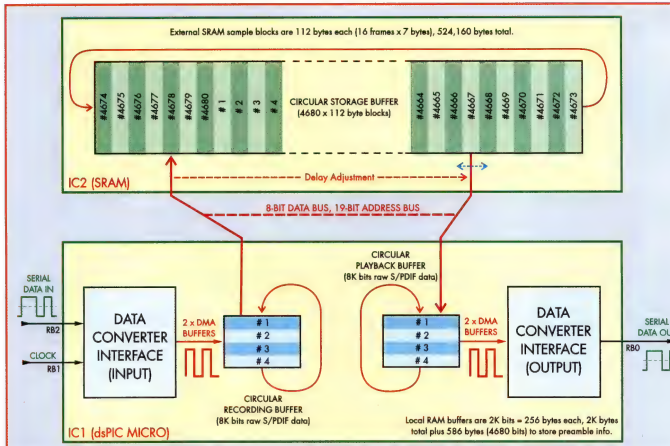


Fig.2: the general audio buffering arrangement. S/PDIF serial data is received by the DCI peripheral and placed into one of two DMA buffers. These are then copied into one of four local RAM buffers (the data is aligned at the same time). The main program loop then decodes the S/PDIF data and copies it into an SRAM block which is later retrieved and re-encoded into one of four output buffers. These are then copied into the outgoing DMA buffers by an interrupt handler and converted into a serial stream again by the output section of the DCI module.

Instruments DIR9001 we are using here. We would need a bigger micro (inevitably a surface-mount type with more pins) in order to reconstitute the S/PDIF stream from these separate data streams.

So we looked for another way. While it is not documented in the data sheet, the DIR9001's system clock output (SCKO) signal is in phase with the incoming S/PDIF stream. This clock is generated by a voltage controlled oscillator (VCO) which is part of a phase-locked loop (PLL). So we use the system clock output to allow the micro to receive and delay the S/PDIF raw data stream. In fact, we don't use any of the output data streams from the DIR9001. We really just use its PLL and VCO.

By tying its PSCK0 and PSCK1 pins to ground, we set the system SCKO clock to 128 times the sample rate, typically 48kHz, giving a frequency of 6.144MHz. The biphase-coded S/PDIF data is clocked at this same rate so the SCKO rising edges coincide with each possible level transition in the S/PDIF data stream.

As a result, the falling edges occur when the data is in a stable state (low or high) and with the micro set to sample the raw S/PDIF data on these edges, the resulting data is an exact replica of the incoming bits. To avoid extra complexity, we also use the clock recovered from the incoming S/PDIF data stream to clock the outgoing delayed data.

Having received the audio data, the micro feeds it into a static RAM buffer for a set period before it is retrieved and output. To delay the raw data stream by one second we would need 6.144MHz x 1s = 6.144Mbit of storage. But we'd rather use a 4Mbit (512KB) SRAM chip since these are cheaper than 8Mbit SRAMs and are available in easier-to-solder packages (and require one less address line).

Our solution is to decode the bi-phase mark coding (BMC) and store the decoded data in RAM. It can then be re-encoded after being read back and before transmission.

This more than doubles the amount

Specifications

Supported formats: Linear PCM up to 48kHz, Dolby Digital (AC-3), DTS and similar compressed formats

Input: S/PDIF coaxial or TOSLINK, selectable by rear-panel switch

Outputs: S/PDIF coaxial and TOSLINK (both available simultaneously)

Delay range: 20-1500ms in 10ms steps; set using a universal remote control

Power supply: 9-12V DC, 150mA plugpack

of data that can be stored in the buffer; each 128-bit S/PDIF frame decodes to 56 bits of data (we discard the preambles and re-insert them later) for an increase in memory usage efficiency of 129%.

With this method, a 512KB SRAM fits over 1.5 seconds worth of data at the typical rate (6.144MHz). The encoding and decoding can be done with RAM table lookups and since the micro saves a lot of time storing and retrieving less data, overall this method is faster too.

The SRAM is used as a circular buffer – see Fig.2. Decoded data is constantly being written to it, starting at the lowest address and working its way upwards and then wrapping around once it reaches the top. Playback occurs from a different position in the buffer and proceeds in a similar manner. The difference between the recording and playback addresses determines the delay.

Since the number of frames and thus the number of bits to delay depends on both the delay time set and the incoming data rate, the difference between the addresses is computed based on the rate at which incoming buffers are being filled. When this rate changes, this is automatically re-calculated. The micro's 8MHz clock (from an external crystal oscillator circuit) is used as the reference frequency, to calculate the absolute time between buffers.

The delay time is set by remote control and is stored in flash memory so that it doesn't have to be reset each time. The delay can be temporarily cancelled or re-instated with a single button press on the remote control.

Operation details

Referring again to the block diagram (Fig.1), for S/PDIF over coax, the signal goes to CON2 and is amplified to 3.3V peak-to-peak. It then passes through switch S1 to microcontroller IC1 and also to S/PDIF decoder IC8 for clock recovery (ie, SCKO). With S1 in the other position, the TOSLINK input (RX1) is selected instead.

Microcontroller IC1 stores the incoming data in 512KB SRAM IC2, using two 8-bit latches (IC3 & IC4) to select the appropriate storage address. The unit is controlled via infrared receiver IRD1. This sends the raw RC5 protocol data to microcontroller IC1 which decodes it.

After having spent an appropriate amount of time in SRAM buffer IC2, IC1 then retrieves the audio data and sends it to TOSLINK transmitter TX1 and also via buffer IC6 to the coax output, CON3.

An 8MHz crystal oscillator provides timing for microcontroller IC1. IC1 uses an internal PLL to generate its 40MHz instruction clock, which is also used to compute the audio delay time.

Circuit description

Refer now to the circuit diagram (Fig.3). This shows the operation in greater detail. The S/PDIF signal from CON2 is AC-coupled by a 100nF capacitor and applied to the input of CMOS inverter IC6a which is operated in linear mode using 10kΩ and 100Ω feedback resistors. Diodes D2 and D3 clamp the signal voltage in case a higher-level signal is accidentally applied to CON2. The 82Ω resistor to ground, in combination with the loading of the amplifier, provides the correct 75Ω termination.

In the past, we used a 300Ω resistor here, the assumption being that 300Ω

Parts List

1 PCB, code 01212111, 103 x 118mm
1 low profile instrument case, 140 x 110 x 35mm (Jaycar HB5970, Altronics H0472)
1 universal remote control (eg, Altronics A1012 or Jaycar AR1729)
1 front panel PCB, code 01212112, 108 x 30mm
1 rear panel PCB, code 01212113, 108 x 30mm
2 100µH axial inductors (L1 & L2)
1 8MHz HC-49 crystal (X1)
1 PCB-mount DC socket (CON1)
1 PCB-mount right-angle slide switch (S1) (Altronics S2070)
2 switched RCA sockets, black (CON2, CON3)
1 3-pin header (2.54mm pitch) and shorting block (LK1)
1 TO-220 micro-flag heatsink (Jaycar HH8502, Altronics H0630)
1 M3 x 10mm machine screw
1 M3 nut
1 M3 washer
1 8-pin DIL socket
2 14-pin DIL sockets
2 16-pin DIL sockets
1 28-pin narrow DIL socket
1 32-pin DIL socket
4 No.9 x 6mm self-tapping screws
1 300mm length 0.7mm diameter tinned copper wire

Semiconductors

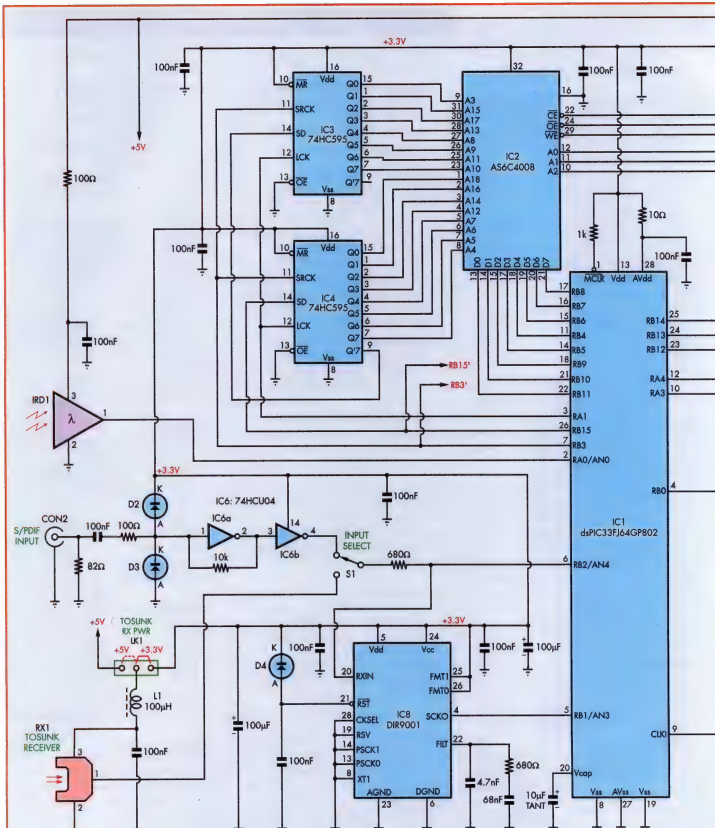
1 dsPIC33FJ64GP802 or dsPIC33FJ128GP802 16-bit microcontroller programmed with 0121211A.hex (IC1)
1 AS6C4008 4Mbit SRAM (IC2)
2 74HC595 octal serial-to-parallel latch ICs (IC3, IC4)
1 74HC00 quad NAND gate CMOS IC (IC5)
1 74HCU04 unbuffered hex inverter CMOS IC (IC6)
1 LM393 dual low-power comparator (IC7)
1 DIR9001 S/PDIF decoder IC [TSSOP-28] (IC8)
1 TOSLINK transmitter (TX1) (Jaycar ZL3000, Altronics Z1603)
1 TOSLINK receiver (RX1) (Jaycar ZL3003, Altronics Z1604)
1 infrared receiver (IRD1) (Jaycar Z1611A, Altronics ZD1952)
1 7805 5V 1A linear regulator (REG1)
1 LM3940IT-3.3 3.3V 1A low-dropout linear regulator (REG2)
1 1N4004 1A diode (D1)
3 1N4148 signal diodes (D2-D4)
1 3mm green LED (LED1)
1 3mm yellow LED (LED2)

Capacitors

4 100µF 16V electrolytic
1 47µF 25V electrolytic
1 10µF 16V tantalum or SMD ceramic (3216/1206)
1 150nF MKT
15 100nF MKT
1 68nF MKT
1 4.7nF MKT
2 100pF ceramic
2 33pF ceramic

Resistors (0.25W, 1%)

1 1MΩ	2 300Ω
2 100kΩ	1 240Ω
3 10kΩ	1 110Ω
1 2.2kΩ	2 100Ω
1 1kΩ	1 82Ω
2 680Ω	2 10Ω



DIGITAL AUDIO DELAY

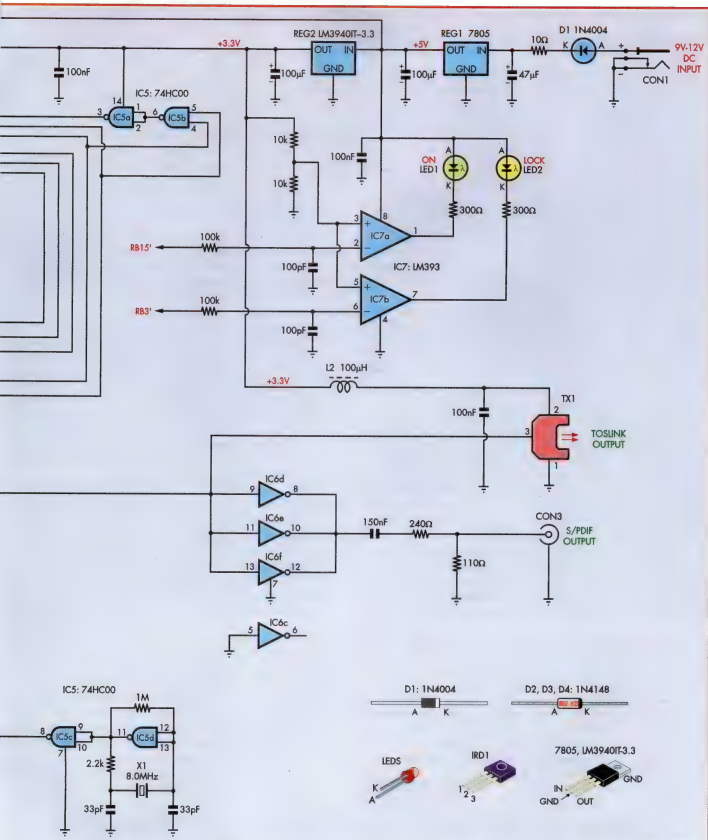


Fig.3: the complete circuit for the Digital Audio Delay. Digital audio is fed in via TOSLINK receiver RX1 or via S/PDIF input CON2 (coax). The CON2 signal is amplified by IC6a & IC6b and fed to switch S1 which then selects between the two digital inputs. S/PDIF decoder IC8 is used to recover the clock signal. Microcontroller IC1 runs the show, buffering the audio data in SRAM IC2. IC3 & IC4 drive 16 out of 19 address lines and are controlled by serial signals from IC1. After a suitable delay, the audio is sent from IC1 to TOSLINK transmitter TX1 and via buffers IC6d-IC6f to CON3 for coaxial output. Infrared control is handled by IRD1 while LED1 & LED2 show status.

What Are S/PDIF And TOSLINK?

The acronym S/PDIF (or SPDIF) stands for Sony/Philips Digital Interface. Basically, it is a standardised serial interface for transferring digital audio data between consumer-level equipment such as DVD and CD players, DAT and DVD recorders, surround-sound decoders and home-theatre amplifiers.

S/PDIF is very similar to the AES3 serial digital interface used in professional recording and broadcasting environments. In operation, each digital audio sample (16-24 bits) is packaged along with status, control and error-checking information into a 32-bit binary word. This is then modulated or encoded into a serial bitstream using the Biphase Mark Code (BMC).

BMC involves combining the data bits with a clock signal of twice the data bit rate, in such a way that a binary "1" results in two polarity reversals in one bit period, while a binary "0" results in a single polarity reversal. This double bit-rate signal is self-clocking at the receiving end and has no DC component.

The BMC encoded serial bitstream is then transmitted as a 400mV peak-to-peak signal along a single 75-ohm coaxial cable. In most cases, the cable connectors used are standard RCA or "Cinch" connectors, as also used for analog audio and composite video.

Although originally developed for conveying linear PCM (LPCM) digital audio signals as used in CD and DAT audio, S/PDIF has also been adapted for conveying compressed digital audio, including Dolby Digital (AC-3), DTS and MPEG-2 audio.

TOSLINK is essentially just the S/PDIF signal format converted into the optical domain, for transfer along optical-fibre cables. The accompanying table (see above) shows the most common domestic audio bitstream formats and the S/PDIF/TOSLINK bit rates for each one. Note that LPCM audio is rarely used for DVD-Video, because even a stereo audio track requires a BMC bit rate of 6.1Mb/s.

Many current-model DVD players and recorders are provided with either coaxial S/PDIF or TOSLINK digital audio inputs and outputs, or quite often a mixture of both. Similarly, many home-theatre amplifiers are provided with coaxial S/PDIF and/or TOSLINK inputs. This is also the case with many up-market PC sound cards.

Digital Audio Bitstream Formats

SOURCE & CODING	CD-Audio (LPCM)	DVD-Video & DAT (LPCM)	DVD-Video (COMPRESSED)		
			DOLBY DIGITAL (AC-3)	MPEG-2 AUDIO	DTS AUDIO
SAMPLING RATE	44.1kS/s	48kS/s	48kS/s	48kS/s	48kS/s
MAX DATA BIT RATE	2822kb/s	3072kb/s	448kb/s	456kb/s	754.5kb/s
SPDIF (TOSlink) BMC BIT RATE	5644kb/s	6144kb/s	896kb/s	912kb/s	1509kb/s

Fig.4 shows the S/PDIF protocol in detail. The data is transmitted with biphase mark coding (BMC). Compare the encoded data to the raw data shown above it. The BMC has a level transition between each bit and an additional transition in the middle if the data is a one (high). So essentially, it is a form of frequency shift keying (FSK).

This results in a signal with an average voltage of half the peak-to-peak amplitude. Also, the clock and data are encoded in a single stream, allowing transmission over coaxial cable. BMC data can be inverted without effect since only transition timing matters.

The disadvantages are increased transmission frequency (twice the bit rate) and the hardware to recover the clock signal is somewhat complex, generally involving a phase-locked loop (PLL).

The S/PDIF protocol consists of an endless sequence of "frames". Each frame contains two sub-frames, which carry the biphase-coded audio samples for the left and right channels (multi-channel formats are explained below).

Each sub-frame starts with a preamble which is not in BMC format (but has zero DC offset). Preambles "X" and "Z" are used to indicate the start of a left-channel subframe while preamble "Y" indicates a right-channel subframe. Without the preambles, it would be impossible to know where the data starts and ends.

The following data consists of 24 bits of audio data (in some cases, the lowest four bits are used to store other information) plus four status bits. The "valid" bit indicates whether the preced-

in parallel with 100Ω is 75Ω. But that assumes that the input to the inverter is held at "virtual ground", which it isn't (its output swing isn't large enough).

The output of IC6a is "squared up" by inverter IC6b and then fed to input RB2 (pin 6) of microcontroller IC1. The software sets this to be the DCI module data input. It also goes to pin 20 of IC8 (RXIN) which generates a synchronised clock signal.

If S1 is in the alternative position, the S/PDIF signal to IC1 instead comes from TOSLINK receiver RX1. It is powered from either 5V or 3.3V (depending on the receiver), as set by LK1. Its supply passes through an LC low-pass filter (100µH/100nF) since it is sensitive to supply noise.

If a 5V TOSLINK receiver is used, the output is 5V peak-to-peak which is clamped to 3.3V by IC1's input clamp diode. The 680Ω series resistor limits the current under this condition to about 2mA. It also forms an (unwanted) RC filter with the input capacitance of both IC pins and stray PCB capacitance. This distorts the square wave but not enough to cause any problems.

Clock recovery

As explained earlier, IC8 is used solely to recover the clock of the S/PDIF signal, allowing IC1 to sample the serial stream at the correct points. Its other functions (audio data extraction, status output, etc) are not needed and so none of its data outputs are used.

IC8 requires a power-on reset (by pulling RST-bar low) and this is provided by a 100nF capacitor, a pull-up resistor (inside IC8) and diode D4. Initially, the capacitor is discharged and so RST-bar is low. The capacitor charges via the internal 51kΩ resistor and so eventually RST-bar goes high and IC8 operates normally. When the power supply is removed, the capacitor rapidly discharges via D4 and the process can then repeat.

IC8 also requires a PLL filter from pin 22 (FILT) to pin 23 (AGND), comprising two capacitors and a resistor. This is a "Type II" compensation network which limits the rate at which the voltage controlled oscillator's output frequency changes. This stabilises the PLL so it doesn't "hunt" around the correct frequency or overshoot too much. For more information on Type II compensation networks, see page 3 of Intersil Technical Brief TB417.1 (**http://**

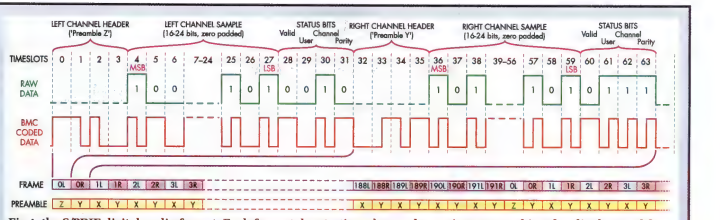


Fig.4: the S/PDIF digital audio format. Each frame takes 64 time slots and contains up to 24 bits of audio data and four status bits for each channel. The data is biphase mark coded and two preambles are added, to distinguish the two channels. There are 192 frames per block and the blocks repeat endlessly.

ing data is an audio sample or something else while the "parity" bit allows transmission errors to be detected.

There are 192 frames in each "block" and one block follows another. The start of the block is indicated by Preamble X (instead of Preamble Z). This allows the other two status bits, "user" and "channel" (channel status), to be interpreted as 24 bytes of data per channel.

The channel status data is interpreted differently for S/PDIF (consumer) and AES3 (professional). In either case, it contains information such as the audio format, sample rate, channel relationship and so on. The meaning of the "user" bits is application-specific.

Multi-channel formats

Formats such as Dolby Digital (AC3) and the Digital Theatre System (DTS) use digital audio compression. So despite the extra channels, the data rate is usually lower than linear PCM (see table). This data is normally transmitted in place of the audio samples with zeros to pad it out to the same size (and thus transmission rate) as linear PCM.

This relies on the home-theatre receiver recognising the compressed data and interpreting it accordingly; if it is treated as linear PCM, the result is loud static. **Note that newer surround-sound formats such as Dolby Digital EX and DTS-HD use higher data rates that may in some cases exceed that of linear PCM. So the Digital Audio Delay unit may or may not handle them.**

Finally, Fig.5 shows how the data stream is carried by coax cable. The transmitter normally produces around 1V peak-to-peak but because the receiving end is terminated with 75Ω (to match the cable impedance), this voltage divider reduces the received signal to around 0.5V. It therefore needs amplification before it can be treated as a standard digital signal.

Fig.5: S/PDIF is transmitted over 75Ω coaxial cable with a nominally 1V peak-to-peak square wave, centred on 0V. With correct 75Ω termination, the receiver gets around 0.5V peak-to-peak.

www.intersil.com/data/tb/tb417.pdf).

The desired output clock rate (128 times the sample rate) is selected by tying the PSCK0 and PSCK1 pins (pins 13 & 14) to ground. The clock signal is available from pin 4 (SCKO) which is connected to pin 5 of IC1 (RB1), the DCI module clock input.

SRAM interface

Microcontroller IC1 interfaces with the AS6C4008 SRAM (IC2) using 14 pins. RB4-RB11 form the 8-bit bidirectional data bus. The order of connection doesn't matter since the bits are always received in the order they were sent. Since RB4-RB11 are contiguous, the software can set or read them all in a few clock cycles.

The three lowest address bits, A0-A2 (pins 10-12), are controlled directly by IC1 (pins 23-25, RB12-RB14). IC1 can therefore read or write eight bytes in quick succession. To access a different set of eight bytes, it sets the 16 remaining address pins (A3-A18) using octal serial-to-parallel latches IC3 & IC4.

These are controlled with a 3-wire serial bus from IC1's pins RB3 (pin 7, clock), RB15 (pin 26, data) and RA1 (pin 3, latch). To set a new upper address, RA1 goes low and then 16 bits of data are output. The transmitted bits first shift into IC4's latches and then pass from its Q7 cascade output to IC3's serial input. When RA1 subsequently goes high, outputs Q0-Q7 of IC3 and IC4 switch to the new address.

Because the shifted data is held in separate latches (within IC3 & IC4) until RA1 goes high, the next address can be transferred while data at the previous address is being read/written. So while the serial addressing is slower than parallel addressing, in reality it doesn't make much of a difference to the access speed for large blocks of data.

IC2's WE-bar, OE-bar and CE-bar lines (pins 29, 24 & 22) control the read and write cycles. For a read, the address line states are set and then both OE-bar (output enable) and CE-bar (chip enable) go low. The value of that byte can then be read from the data bus.

To write a byte, both the address and data line states must be set and then WE-bar (write enable) and CE-bar are brought low. After a brief period, the write is completed and these lines can go high again.

To free up one of IC1's pins, NAND

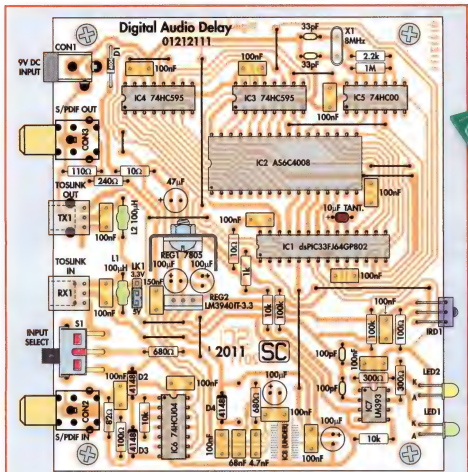


Fig.6: follow this overlay diagram to build the PCB. Note that the wire links shown will not be necessary if the PCB supplied is double-sided. Set jumper LK1 to 5V for the Jaycar and Altronics TOSLINK receivers specified (the Altronics receiver can also run of 3.3V) and check the data sheet for other types.

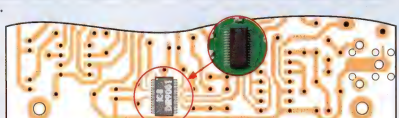
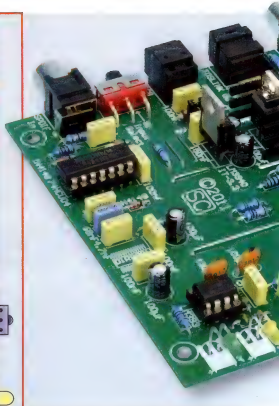


Fig.7: this diagram shows how the DIR9001 S/PDIF decoder IC is mounted on the copper side of the PCB – see text for details. If you inadvertently bridge two or more of the pins, the excess solder can be removed using solder wick.



gates IC5a and IC5b drive the chip enable (CE-bar) line. These control it so that if either WE-bar or OE-bar go low, so does CE-bar. IC5b performs the NAND function and its output is inverted by IC5a, converting it to an AND operation.

The other two sections of IC5, IC5c and IC5d, also function as inverters and form an oscillator with crystal X1. The 8MHz output is then used by IC1 to provide its 40MHz instruction clock which is also used for timing the S/PDIF signal. IC1 has an internal crystal oscillator but it requires the use of two micro pins while an external clock source only ties up one.

S/PDIF output

IC1 routes its DCI serial output to pin 4 (RB0) which is connected to the input of TOSLINK transmitter TX1. Like RX1, its power supply has an LC low-pass filter to provide glitch-free operation. Most TOSLINK transmitters run off 3.3V so we haven't provided a 5V supply option in this case.

The output signal also goes to the inputs of inverter stages IC6d-IC6f, connected in parallel for more output current as they drive a relatively low impedance (300Ω). The 150nF capacitor AC-couples the output so that it is symmetrical about ground while the 240Ω and 110Ω resistors reduce the signal amplitude to about 1V peak-to-peak. They also set the output impedance to 75Ω, which matches the expected cable impedance. Unused inverter IC6c has its input connected to ground.

User interface

Infrared control signals are received by IRD1. Its power supply is low-pass filtered with a 100Ω resistor and 100nF capacitor because it too contains sensitive analog circuitry. Its output is fed to IC1's RA0 digital input (pin 2). An infrared signal triggers a software interrupt and the software then decodes the received RC5 pulses and takes appropriate action.

While IRD1 runs off 5V and IC1 off 3.3V, no current-limiting resistor is used between them since IRD1's output is pulled high by a relatively high-value internal resistor (normally 10-47kΩ). Thus the current into IC1's

The PCB assembly fits into a low-profile instrument case which can be spray-painted matte black to match other audio gear. In addition, the front and rear panels are replaced with new PCB panels which have all the necessary holes plus screened lettering on a dark blue solder mask background.

clamping diode is inherently limited.

Feedback to the user is via LEDs1 & 2. The micro pins controlling these LEDs are shared with the serial address bus. Because this bus (to IC3 and IC4) is not always in use, IC1 can "idle" the serial data and clock lines high (3.3V) or low (0V). Since they are idle for much of the time, this determines their average voltage. These average voltages are filtered using 100kΩ resistors and 100pF capacitors.

The filtered voltages are compared by IC7, a dual comparator, to a half-supply (1.65V) reference derived from two 10kΩ series resistors. The LM393 runs off 5V so that it can handle input voltages of up to 3.5V.

If the average voltage of either RB15 or RB3 is above 1.65V, the corresponding open-collector output of the comparator (pin 1 or pin 7) goes low, turning on LED1 or LED2 respectively. So the idle state of RB15 controls LED1 (high = on, low = off) and likewise, RB3 controls LED2. The 300Ω current-limiting resistors set the LED current to about 10mA.

Power supply

The power supply uses linear regulators to derive 5V (REG1) and 3.3V (REG2) supply rails from a 9-12V DC plugpack. Diode D1 (1A) provides reverse polarity protection while a 10Ω series resistor slightly reduces the dissipation in REG1. REG1 has a small flag heatsink, allowing supply voltages up to 12V (nominal).

REG1 is a standard linear regulator while REG2 is a 1A 3.3V low-dropout regulator. These are fussier about their output capacitor but any decent 100µF electrolytic will be suitable (with an ESR in the range of about 0.05-2Ω).

Each IC in the circuit has a 100nF MKT supply bypass capacitor, located as close to its supply and ground pins as possible. These prevent each IC's supply voltage from sagging briefly when internal switching causes it to draw brief but relatively high current pulses.

IC1 has an additional bypass capacitor for its AVdd analog supply (pin 28), with a 10Ω series resistor for better smoothing. A 10µF tantalum capacitor on pin 20 (Vcap) filters the output of its internal 2.5V regulator, from which its core runs. Since tantalum capacitors can have poor reliability, we have made provision for a 10µF surface-mount ceramic capacitor as well.

IC8 also has two bypass capacitors, one for Vdd (its digital supply) and one for Vcc (analog supply), both 3.3V. These also have parallel 100µF electrolytic capacitors to stiffen its supply at lower frequencies (up to a few hundred kHz).

Finally, IC1 has a 1kΩ pull-up resistor on its MCLR-bar (reset) pin to prevent spurious resetting due to electrical noise.

Construction

The Digital Audio Delay is built on a 103 x 118mm PCB coded 01212111 – see Fig.6. This fits into a low profile instrument case (140 x 110 x 35mm).

The first step is to solder the SMD IC (IC8) in place – see Fig.7. It is in a 28-pin TSSOP (thin shrink small outline package) device with a pin pitch of 0.65mm. It isn't too difficult to solder with the right tools. If you are building it from a kit and the SMD IC is already in place, skip to the next section.

Place the PCB copper-side up and apply a very small amount of solder to the upper-right pad with a clean soldering iron (use a medium to small conical tip). If you are left-handled, start with the upper-left pin instead.

That done, pick up the IC with tweezers (the angled types work well) and position it near the pads with the correct orientation, ie, its pin 1 dot positioned as shown on Fig.6. Heat the tinned pad, slide the IC into place and remove the heat.

Check its alignment carefully (use a magnifying glass if necessary). It should be straight, with all the pins over their respective pads and an equal

How The Software Works

AS WITH MANY projects involving microcontrollers, a lot of the effort has gone into the software. The hardest part were the routines to lock onto, decode and re-encode the S/PDIF stream in real time, with enough cycles left over for SRAM reading/writing, infrared decoding, etc.

When the DCI (data converter interface) peripheral is activated, it starts receiving the S/PDIF data into RAM buffers, starting with whichever bit happens to come along first. While an audio block is an integer multiple of the buffer size, there is no guarantee of proper alignment; in fact the chance of this happening is very low (see Fig.8).

We initially tried a number of methods to "re-align" the hardware buffers to the S/PDIF stream but these turned out to be slow and unreliable. Instead, the alignment is done by the software. It scans each received buffer for a valid preamble, one bit at a time. If it finds one, it stores that bit offset and looks at the same position in the next buffer. If the preamble appears in the same position in subsequent buffers, the software has locked onto the S/PDIF stream. It can then shift the bits when copying from the DMA buffers into the local RAM buffers, realigning it as required by the decoding function.

To speed up decoding, several RAM look-up tables are generated at start-up. It's then just a matter of using the BMC-coded data as an index into that table, one byte at a time, to retrieve the decoded equivalent. The re-encoding process uses a different table in a similar way.

The main program loop constantly transfers decoded data to the SRAM (IC2). At the same time, it reads back data from a different location and re-encodes it, inserting the appropriate preambles. This then goes to one of four outgoing buffers, which are transferred into DMA space when appropriate by an interrupt handler, to be serialised and transmitted.

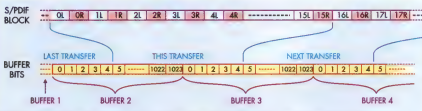


Fig.8: there's no easy way to align the S/PDIF data with the DCI receiver buffers so it's normally offset. As a result, the S/PDIF blocks usually start in the middle of a buffer. This is corrected for by the software, which scans the buffer for a valid preamble sequence and then shifts the data into alignment.

Writing to flash

Since this microcontroller has no EEPROM (electrically erasable programmable read-only memory), the delay must be stored in flash memory. Microchip provide an EEPROM emulation library to do this but using it caused a glitch in the audio output each time the delay value was changed.

It turns out that their function waits for the flash write to complete before re-enabling interrupts and returning program control to the main loop. This means that the DMA interrupt handlers can't feed data to the DCI for that period and this is long enough to cause a drop-out.

We increased the DMA buffer size but it didn't solve the problem. In the end, we wrote our own EEPROM emulation functions, which have the following differences:

- Two 12-bit values stored per program word, rather than one, increasing flash memory life.
- Simpler logic (since there's only one value to store), speeding up the write function.
- Virtually all page erases are done at start-up to avoid extra delays during operation.

Interrupts are re-enabled and control returned to the program as soon as the write is initiated. Our software includes a timer to delay subsequent updates to avoid problems (and to minimise the number of writes).

We also changed the code to always do the flash writes just after a new DMA buffer has been fed to the DCI unit. This is the time at which the DCI buffer is most full, giving the flash write as much time to complete as possible before the buffer needs to be refilled. That solved the problem.

We don't have room here to describe the software in full. The source code is available in a ZIP file from the SILICON CHIP website.

amount of exposed pad on either side. If not, reheat the solder joint and gently nudge the chip in the right direction. Repeat until its position is perfect then solder the diagonally opposite pin.

Re-check the orientation and re-adjust it if necessary before soldering the remaining pins. Don't worry too much about solder bridges; they are virtually inevitable and can be easily fixed. The most important job now is to ensure that the solder flows onto all pins and pads.

That done, apply a thin smear of no-clean flux paste along all pins and remove the excess solder using solder wick. Once the flux is heated to boiling point, this should happen quickly. Be sure to trim the end off the wick if it gets solder-logged.

You should now make a final and careful inspection to ensure that there are no remaining solder bridges and that the solder has not balled on the lead without flowing onto the pad. If there are still bridges, clean them up with more flux and solder wick.

Through-hole parts

Now install the 14 wire links using 0.7mm diameter tinned copper wire. Follow with the resistors, checking each with a DMM to ensure the correct value is used in each case.

Fit the three 1N4148 small signal diodes (D2-D4) next, with the orientation as shown on the overlay diagram (cathode stripes to the top). Then install diode D4 (1N4004) at upper left with the opposite orientation.

Next up are the two axial inductors L1 & L2 and then the IC sockets. Make sure the notches for the sockets go either to the left or to the top – see Fig.6.

That done, mount the four ceramic capacitors and then the MKTs, starting with the 4.7nF, 68nF and 150nF where shown (the rest are all 100nF).

The electrolytic and tantalum capacitors can then go in. The tantalum type should have a "+" symbol on the body and it must be orientated as shown (towards the left). If you are using an SMD ceramic instead, it goes

on the underside of the PCB. For the aluminium electros, the longer lead goes towards the side marked "+". Don't get the 47µF and 100µF types mixed up.

Crystal X1 is next on the list and then the connectors and slide switch can go in, starting with the lowest profile part. Ensure they are all flat against the PCB and parallel to the edge before soldering them. **LK1 goes in next, with a shorting block (jumper) fitted to suit your TOSLINK receiver: 5V for the Jaycar ZL3003 and either 3.3V or 5V for Altronics Z1604 (for others, check the data sheet).**

The leads for the LEDs and infrared receiver (IRD1) need to be cranked before they can be installed. Bend the LED leads down 5mm from the lens, so that the anode (longer lead) will go into the pad closest to the bottom edge of the PCB. Mount them with the horizontal portion of the lead 7mm above the PCB (a 7mm-wide strip of cardboard can be used as a spacer).

Now for IRD1. Bend its leads backwards through 90° 2mm from its body, then back down again 5mm behind that. It then goes in with the horizontal lead section sitting on top of the PCB.

Regulators

Before installing REG1 (7805), fit the small flag heatsink to its tab as shown on Fig.6, with a washer under the screw head. That done, solder it to the PCB with the tab towards the top. REG2 goes in the opposite way (it doesn't need a heatsink).

The PCB assembly can now be completed by plugging the ICs into their sockets, ensuring that the notch/dot is orientated as shown in each case. Be careful not to get IC5 and IC6 mixed up.

The Jaycar AR1729 remote – program it with code 916 for a Philips VCR.

The Altronics A1012 remote – it's programmed with code 115 for a Philips VCR.

Housing it

If using the recommended case, you may wish to spray-paint the top and bottom pieces matte black, as we did.

We lightly glued a couple of empty wire reels to the underside of the lid and base to act as stands. We then sprayed both with one coat of primer and then three thin coats of flat black. You can get a better finish if you do this indoors (eg, in a garage) but if you do this you will need to make a spray booth (eg, a large cardboard carton).

The front and rear panels shown in the photos are actually PCBs with blue solder masks and white screened lettering. These are mechanically strong, look good, are relatively cheap and the labels and cut-outs are already done for you.

It's just a matter of slipping them onto the ends of the PCB assembly, then slotting the whole assembly into the case and screwing the board down using four self-tapping screws. The lid can then be attached.

Testing

If you have a bench supply, set the

Table 2: Capacitor Codes

Value	µF Value	IEC Code	EIA Code
150nF	0.15µF	150n	154
100nF	0.1µF	100n	104
68nF	0.068µF	68n	683
4.7nF	.0047µF	4n7	472
100pF	NA	100p	101
33pF	NA	33p	33

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	1MΩ	brown black green brown	brown black black yellow brown
❑	2	100kΩ	brown black yellow brown	brown black black orange brown
❑	3	10kΩ	brown black orange brown	brown black black red brown
❑	1	2.2kΩ	red red red brown	red red black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	2	680Ω	blue grey brown brown	blue grey black black brown
❑	2	300Ω	orange black brown brown	orange black black black brown
❑	1	240Ω	red yellow brown brown	red yellow black black brown
❑	1	110Ω	brown brown brown brown	brown brown black black brown
❑	2	100Ω	brown black brown brown	brown black black black brown
❑	1	82Ω	grey red black brown	grey red black gold brown
❑	2	10Ω	brown black black brown	brown black black gold brown

The completed unit is neat and compact. There are no external controls – the delay is set using a universal remote control and once set, should not need further adjustment.

output to 8V DC 200mA and apply power to CON1. If the current draw is over 150mA (typically 120mA), switch off and check for faults. If you don't have a bench supply, simply connect the plugpack and check the LEDs.

When power is applied, LED1 (green) should flash slowly four times as the micro performs an SRAM test. If a memory fault is detected, LED1 goes off and LED2 (yellow) flashes rapidly. If the SRAM is OK, LED1 turns on and stays on.

If not, check for faults. Specifically, check the orientation of all polarised components: tantalum and aluminium electrolytic capacitors, diodes, LEDs, ICs and regulators. Also check that there are no solder bridges between pads on the underside of the PCB, especially around IC8. Measure both power supply rails; they should be in the range of 3.0-3.6V and 4.75-5.25V.

Assuming all is well, you can connect a test signal. Be sure set S1 according to which input you use (TOSLINK or S/PDIF). Now turn on the signal source and play some media. When a valid signal is detected, LED2 (yellow) should turn on and stay on to indicate signal lock.

If you do not get a signal lock, connect a frequency counter between the wire link running to pin 5 of IC1 and a ground point (eg, regulator tab). You should get a reading of several MHz; typically around 6.144MHz.

If you get a much lower reading, check the frequency at the middle pin of switch S1. This should be slightly lower, around 4MHz. If this is not present, there is a problem with the S/PDIF reception circuitry. Check the power supply rails and examine the problem area for soldering faults or component problems.

If there is a signal on the middle pin of S1 but not pin 5 of IC1, that suggests a problem with IC8. Check its surrounding components and the soldering of its pins. The anode of D4 should be at about 3.3V.

Using it

To set the delay, you need a universal infrared remote control (eg, Jaycar AR1729 or Altronics A1012), set for a Philips VCR. For the Jaycar AR1729 the code is 916 and for the Altronics A1012, use 115. For other universal remotes, try various Philips VCR codes until the mute button toggles the green LED. The yellow LED flickers when a valid RC5 transmission is received.

You can then use the following buttons to set the delay:

- 1-9: sets the delay to 100-900ms.
- 0: sets the delay to 1000ms.
- Channel Up/Down: increases/decreases the delay by 100ms, to a maximum/minimum of 1500/20ms.
- Volume Up/Down: increases/decreases the delay by 10ms.
- Mute: toggles the delay defeat (or delay bypass).

The front-panel LEDs respond as follows:

- Green: slow flash = testing memory; fast flash = buffering audio; on = operating; off (yellow on) = delay defeat mode.
- Yellow: fast flash = memory error; on = locked onto S/PDIF signal: flicker = infrared activity.

Check that the delay is turned on (green LED on) and then tune into a broadcast or play some media. Observe the delay between the picture and the sound. If the sound is "early", increase the delay. If the sound is "late", decrease it. Typically, you will need to delay the sound by 100-200ms.

If you change the delay, it is automatically saved to internal flash memory and this is then loaded each time the unit is powered up. The defeat mode is reset on power-up, ie, it is not remembered. SC

Kit Availability

Jaycar has indicated that they will produce a complete kit of parts for this project. This kit (Cat. KC-5506) will be supplied with screen-printed front and rear panels and with the DIR9001 surface-mount chip soldered in place.

Alternatively, the PCB (without the DIR9001 IC), the front and rear panels and a programmed microcontroller (dsPIC33FJ64GP802 or dsPIC33FJ-128GP802) are available separately from SILICON CHIP.

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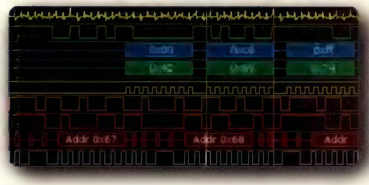
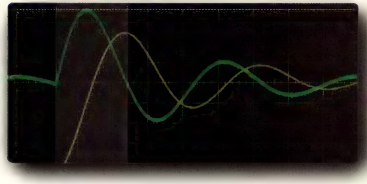
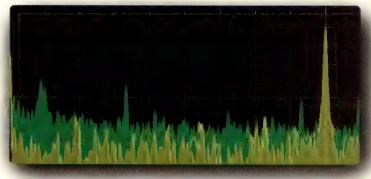


Digital Oscilloscope



Spectrum Analyzer



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WANT CONSISTENTLY GREAT HOME-BREW?

BUILD THIS MAGNETIC STIRRER!

Design by Michael Burton

You probably know that magnetic stirrers are widely used in chemistry and biology laboratories – but a more down-to-earth reason for having one is if you brew your own beer. Why? It is great for making activated yeast, as Michael Burton explains. He came up with the basic design and we refined it (a bit).

So what is a magnetic stirrer? In essence it is a small machine which produces a rotating magnetic field. On it you place a flask or beaker containing the liquid(s) you want to stir.

The stirring action is produced by a short bar magnet encapsulated in an impervious plastic. It is spun by the rotating magnetic field and you can leave it to do its job for as long as you like.

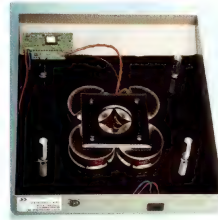
Why stir a mixture yourself when a machine can do it for you?

Magnetic stirrers used in chemistry and biology labs often incorporate a temperature-controlled hotplate. Typically, they use four electromagnets which are alternately switched to provide a pseudo rotating magnetic field. In other words, the magnetic field does not actually rotate but by suitably fiddling with the speed knob you can get the mixture to start spinning and then you increase the speed knob to its desired setting.

We include a photo of the workings of one of these machines.

So now that you have a broad picture of how magnetic stirrers work, you are probably wondering how they are used in home brewing.

In general, beer is made of four things: sugars, hops, water and yeast. When you make a batch of home brew, you mix sugars, hops and water in a big barrel, add your yeast, then soon enough the yeast will "wake up" and



A commercial unit which was the inspiration behind this project. It uses four electromagnets which are sequentially switched to simulate rotation.

OK, we admit it: we're not stirring yeast wort – in fact, it's orange cordial! This photo was taken so you can see the stirring action (the vortex) created by the spinning magnet in the solution, driven by the specially modified fan in the box underneath. The only controls are an on/off switch and a speed controller knob.

start fermenting the sugars to make alcohol.

The trouble is that until the yeast is active you have a barrel of sweet vulnerable wort, just asking for any bacteria to gorge itself and start multiplying.

If unwanted bacteria gets a foothold before the yeast takes over you will get a beer that tastes anywhere from mediocre (if you're lucky) to *yukkk*!

Interestingly, every batch of beer is infected to some extent with unwanted bacteria. The job of a good brewer is to keep unwanted bacteria to a minimum.

This is why sanitation and cleanliness is paramount in home brewing. Second to this, we can minimise the chance bacteria will have to get a foothold by pitching yeast that is already activated (awake and active).

This way the yeast will start fermenting the beer right from the start and drastically reduce the opportunity for unwanted bacteria to multiply and spoil your beer.

Why isn't yeast already active?

Without the presence of sugars to consume, yeast cells become dormant and the longer they are dormant, the longer they take to become active again.

So even if you buy a fresh liquid yeast culture from a home-brewing store, it has usually spent weeks or months in a dormant state and it will take numerous hours to become active after being pitched into the wort.

Many brewers also use dry (dehydrated) yeasts. If you ever buy a home brew can from your local supermarket you will find a sachet of dehydrated yeast under the lid.

These can take a very long time to activate which can spell bad results for your pride and joy if it is pitched in directly (and often that's just what the instructions will tell you to do).

The solution to this trouble is to activate your yeast well in advance of when you have to pitch it.

So you need to plan ahead to ensure that your yeast culture is awake and ready to start fermenting immediately. And they will be in good shape to compete with any undesirable bacteria strains that have crept in to your wort before they take hold.

Activating yeast cultures involves providing them with a sterile, sugar-rich, well-oxygenated solution in which they can wake up at their own leisure.

For this you can use a 1 to 2-litre flask; fill it half with water, add some sugar and pitch the yeast. Dormant yeast tends to sink to the bottom of the vessel and it needs to be stirred up – which will drastically speed up the awakening process.

Here is where your magnetic stirrer comes to the rescue. It offers a way to keep the starter mixture moving and holding the yeast in suspension, while also being completely sterile.

You simply sterilise the stir bar ("flea"), drop it in the mix and it will get the yeast mixture fully active so it can be pitched into the wort, ready to work its magic to ferment the brew.

Making your own stirrer

You probably already have some of the components you need for a magnetic stirrer, such as a surplus 12V computer axial box fan, a 12V DC plugpack and perhaps a suitably sized

The stir bar, actually called a "flea" is simply a small bar magnet encapsulated in some material that is impervious to the solution being stirred – PVC, for example. It is absolutely essential that the flea is sterilised before use to ensure that harmful bacteria are not introduced into the mix. An encased rectangular bar magnet may work even better than the rounded one shown here, because it will create more turbulence.

Just about any old (or even new!) 12V DC fan will do the job – this one was salvaged from a junked computer power supply. The two rare-earth magnets are glued to the rotating motor hub (not the blades!) using a super-strength adhesive such as JB Weld. The last thing you want is those magnets flying off!

plastic jiffy box.

What else do you need? A pair of super-strong magnets to be glued to the fan and a speed control circuit. The magnets (which are often referred to as "rare earth" magnets, super magnets or even scary magnets!) are easily obtained: try Jaycar or even eBay.

The speed control is easy too – we have used the nifty LM317 adjustable regulator PCB featured elsewhere in this issue (originally from May 2007).

In fact, to make the job easy we simply purchased the Jaycar kit for that project; Cat KC-5446. However, we have made a few simple changes. The main one is to substitute a 2kΩ linear potentiometer for the 2kΩ trimpot which would normally be installed on the PCB.

Apart from that, the prototype made by Michael Burton incorporated a DC socket for the 12V plugpack, a 12V LED bezel, an SPST toggle switch for power on/off and a 2-pin header to suit the plug for the 12V computer fan he used.

Assembling the PCB takes only a few minutes. Since a typical 12V fan is not likely to draw any more than about 250 to 300mA, no heatsink will be required for the LM317 regulator.

The prototype magnetic stirrer was assembled into a plastic case obtained from Futurlec.

Alternatively, you could just use an appropriately sized plastic zippy box to accommodate the fan you decide to use. Whichever zippy box you use, the lid should be used as the base of the finished unit. The reason for this is that there will inevitably be spillages and by having the lid as the base you reduce the possibility of any fluids getting into the box.

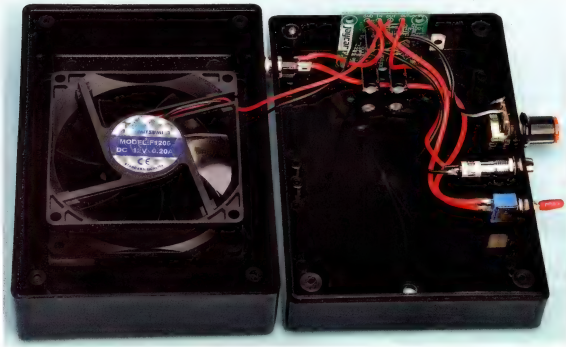
We have not included any PCB component or wiring details with this article as we will let the photos tell the story.

Assuming you have assembled the LM317 regulator PCB, the next step is to work on the plastic case and the fan.

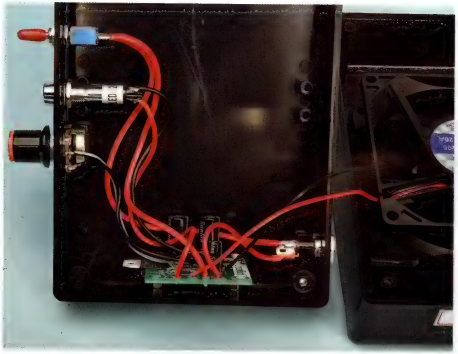
You need two small high power magnets and they are glued to the rotating hub of the fan, as shown in one of the photos.

Don't use just any adhesive because the magnets will be subject to high centrifugal forces. We used JB Weld epoxy adhesive which gives a really strong bond.

Gluing the magnets does tend to be a little tricky. You obviously cannot use



Here's how it all goes together inside the box, which also becomes the base for the container being stirred. The fan is held in place using double-sided adhesive foam pads on the four corners. These not only hold it tight but also give a couple of millimetres of clearance for the magnets glued to the fan hub. Test for clearance before finally securing the fan – if you need to, add a second layer of pads.



Another view of the case, this time from above showing the mounting of the regulator PCB, power supply socket and the three controls.

a steel tool to apply the adhesive to the magnet because it will inevitably jump on to the tool and then it is a messy job trying to extricate the two.

A better approach is to put two small dollops of adhesive on the rim of the hub where you want the magnets positioned and then place the magnets.

Even then, the magnets will tend to move slightly, to be "where they want to be" as they interact with the magnetic rotor of the fan. If there is room, a clamp may help hold them in place while the glue is setting.

Leave the adhesive to cure for at least 10 hours (24 is better), just to make sure that the magnets are rigidly in place.

The next task is to drill the case with the various holes needed to mount the hardware: DC socket, 12V LED bezel, potentiometer, miniature toggle switch and the holes for the screws to mount the regulator board.

We elected to mount the regulator board vertically at one end of the case, adjacent to the DC socket. Again, the photo tells the story.

Wiring the regulator board to the hardware does present a problem with the original design, simply because there are not enough points on the board to terminate the DC supply input, the 12V LED bezel and the switch.

Fortunately, there are extra ground points on the board which cater for different types of trimpot, sizes of electrolytic capacitor etc and this made it possible to wire everything up. However, we have now revised the design of the regulator board to provide 2-pin headers for these connections. The modified design is featured elsewhere in this issue.

The fan needs to be centrally mounted on the base of the case (which becomes the top of the finished magnetic stirrer). The fan can be attached with double-sided foam tape which also provides the necessary clearance so the magnets on the fan do not foul the case. SC

Parts list – Magnetic Stirrer

1 Voltage regulator kit (Jaycar KC-5446 or similar) or the new MiniReg elsewhere in this issue
1 ABS or similar case, size to suit
1 12V DC computer-type axial box fan
1 12V DC plugpack (500mA or so)
2 mini "rare earth" magnets (eg Jaycar LM1618, 1622)
1 bar magnet, encapsulated in PVC etc.
1 SPST mini toggle switch
1 2kΩ linear potentiometer with knob
1 LED with bezel
1 DC input socket (size to suit your 12V supply)
JB Weld 2-part adhesive
hookup wire, nuts & bolts, etc

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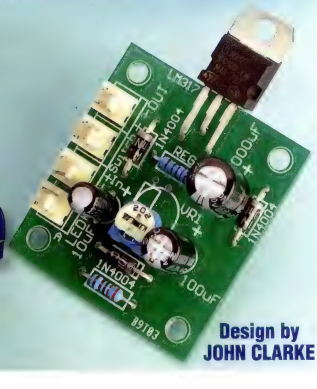
For those times when a fixed regulator is not suitable. . .

MiniReg 1.3-22V adjustable regulator



Design by
JOHN CLARKE

This compact regulator PCB can be used to produce a fully regulated DC supply ranging from 1.3V to 22V at currents up to 1A. Depending on how much current you need, it can fit into tiny spaces and is easily connected with 2-pin headers for DC input, DC output, an on/off switch and a LED.

There are many fixed-voltage IC regulators available such as those with 5V, 6V 8V, 9V, 12V & 15V outputs. But what if you want a voltage output that does not fit into one of the standard ranges or if you want to be able to easily adjust this output voltage?

The MiniReg is the answer: it can be set to provide the exact voltage you require. It's based on an LM317T 3-terminal regulator. The PCB has only a few other components: three diodes, three capacitors, two resistors and a trimpot to set the output voltage from the regulator.

Circuit details

Fig.1 shows the circuit details. The LM317T adjustable regulator provides a nominal 1.25V between its OUT and ADJ (adjust) terminals. We say it is a "nominal 1.25V" because, depending on the device, it can be anywhere between 1.2V and 1.3V. This doesn't really matter though, because we can adjust the output voltage to the required level using the trimpot VR1.

The output voltage from REG1 is set by the 110Ω resistor (R1) between the OUT and ADJ terminals and by the resistance between the ADJ terminal and ground.

This works as follows: by using a 110Ω resistor and assuming an exact 1.25V reference, the current flow is set at 11.36mA. This is calculated by dividing the voltage between the OUT and ADJ terminals (1.25V) by the 110Ω resistor. This current also flows through trimpot VR1.

This means that if VR1 is set to a value of 1kΩ, then the voltage across this resistor will be 1kΩ x 11.36mA or 11.36V. This voltage is then added to the f1.25V reference to derive the output voltage – in this case 12.61V.

In practice, the current flow out of the ADJ terminal also contributes slightly to the final output voltage. This current is of the order of 100µA. So if VR1 is set to 1kΩ, this can add 0.1V to the output, ie, we get 12.71V.

If you are interested in the output voltage equation, then it is:

$$V_{OUT} = V_{REF}(1 + R1/R2) + I_{ADJ} \times R2$$

where V_{OUT} is the output voltage, V_{REF} is the voltage between the OUT and ADJ terminals and I_{ADJ} is the current out of the ADJ terminal (typically 50µA but as high as 100µA).

R1 is the resistance between the OUT and ADJ terminals, while R2 is the resistance between the ADJ terminal and ground.

Diode D1 in series with the input provides reverse polarity protection.

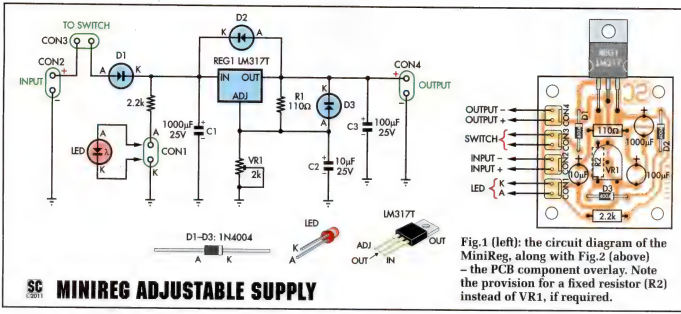


Fig.1 (left): the circuit diagram of the MiniReg, along with Fig.2 (above) – the PCB component overlay. Note the provision for a fixed resistor (R2) instead of VR1, if required.

This means that if you connect the supply voltage around the wrong way, you cannot do any damage.

Diode D2 protects the regulator if the input becomes shorted to ground while it is powered up. Without D2, current would attempt to flow back from the output capacitor through the regulator to the shorted input and that could kill it. But D2 becomes forward biased and conducts, effectively preventing any reverse current flow through REG1.

Diode D3 is also included to protect REG1. It does this by clamping the voltage between the ADJ terminal and the OUT & IN terminals in the event that one of the latter is shorted to ground.

Finally, capacitors C1 & C2 reduce ripple and noise by bypassing the IN (input) and ADJ terminals respectively. C3 prevents regulator oscillation by swamping any low-value capacitance that may be connected to this output.

Construction & options

All the parts for the MiniReg are mounted on a 35 x 38mm PCB, coded 18112111. Fig.2 shows the parts layout. This shows an identical component layout to the PCB in the photo but there is nothing to stop you from making a few changes. For example, do you want to use a conventional potentiometer to vary the output voltage, rather than using the on-board trimpot?

No problem: just omit the trimpot and wire up the external potentiometer in the same way.

Or do you want to use a 12V LED bezel instead of LED1? Again, no problem; especially if your DC input voltage is reasonably close to 12V. In that case, replace the 2.2kΩ resistor with a wire link and wire the 12V LED to the 2-pin header for the LED.

Similarly, you might want to omit the on/off switch. In this case, just install a 2-pin shorting link on the 2-pin header for the switch.

Assembling the PCB is not likely to take very long. You can begin by installing the 110Ω resistor (R1) and the three diodes, making sure the latter are all oriented correctly (the banded ends are the cathodes). Then capacitors C1-C3 can be installed, again taking care with their orientation since they are all electrolytics.

Next, install the four 2-pin headers. You will need to make up four matching cables with 2-way polarised header connectors. We discuss how to make these later.

The 3-terminal regulator can then be mounted. It can either be mounted on the top of the PC board (as shown in the photo) or underneath it, so that it can be fastened to a heatsink.

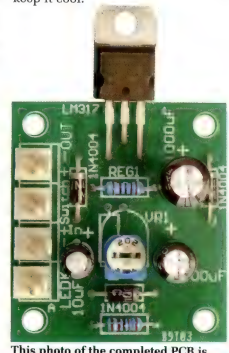
Do you need a heatsink?

Whether or not you need a heatsink for REG1 depends on how much power it is likely to dissipate.

The output current and the voltage between the IN and OUT terminals of the regulator are the critical values. That's because these two values together determine the power dissipation within the regulator. It's determined simply by multiplying the two values together to get the power dissipation in watts, ie, P = VI.

Generally, if the dissipation is less than about 0.5W or 500 milliwatts, no heatsink will be required. For example, if the current drawn from the regulator is 100mA and the voltage between the IN and OUT terminals is 5V, then the dissipation will be 0.5W and no heatsink will be necessary.

However, if the dissipation is more than this or if it is installed in in a small, enclosed space, you will need to fasten the regulator to a heatsink to keep it cool.



This photo of the completed PCB is deliberately over-size for clarity, so you can see exactly what goes where. Note the resistor (R2) shown on the PCB under/adjacent to VR1 is in case you want to substitute a fixed resistor to give you a specific output voltage.

Parts List – MiniReg

1 PCB, 35 x 38mm, code 18112111
4 2-way polarised pin headers, 0.1in spacing (with matching leads – see below)
1 LM317 variable voltage regulator
3 1N4004 power diodes
1 LED (any colour)
1 1000µF 25V electrolytic
1 100µF 25V electrolytic
1 10µF 25V electrolytic
1 110Ω 0.25W resistor
1 2.2kΩ 0.25W resistor
1 2kΩ PC-mount trimpot
(Heatsink, silicone insulator, etc if needed)

For example, let's say that the current drawn from regulator REG1 is 250mA and that the voltage across it is 5V. In this case, the dissipation will be 1.25W (ie, 5 x 0.25) and a heatsink *will* be necessary.

The type of heatsink required depends on the wattage dissipated by the regulator and the temperature rise that can be tolerated.

Typically, a 20°C rise in heatsink temperature is OK because this means that at a typical room temperature of say 25°C, the heatsink will run at 45°C, which is quite acceptable.

Most heatsinks are specified by their temperature rise in °C per watt (°C/W). This means that a 10°C/W heatsink will rise 20°C above ambient when dissipating 2W.

Usually, it will be necessary to electrically isolate the tab of the regulator from the heatsink. The reason for this is that the heatsink may be connected to ground, while the regulator tab sits at the output voltage.

To isolate the tab, use a TO-220 silicone insulating washer and secure the assembly to the heatsink using an M3 Nylon screw and nut. Alternatively, you can use a metal screw provided you fit an insulating bush into the regulator tab.

Note that capacitor C1 may need to be increased in value if the input voltage has a lot of 100Hz ripple.

In addition, you should make sure that the input voltage does not go above C1's 25V rating. Increase C1's voltage rating to at least 35V if it does. In fact, you can apply up to 35V to the input if C1 is a 35V type.

Making up connecting leads

As noted above, you will need to make up four cables with polarised 2-way header connectors. We show how to do these in the panel below.

Adjusting the output

Note that the input voltage applied must be several volts higher than the required output voltage. This is necessary in order to provide regulation.

The minimum voltage across REG1 required for regulation is called the "dropout voltage". For the LM317T, this voltage varies with the current and is typically 1.5V for currents below 200mA, rising to 1.7V at 500mA and 2V at 1A.

Note that the drop across diode D1 must be added to the dropout voltage in order to calculate the required input voltage.

For example, if our power supply draws 200mA and the required output voltage is 6V, then the input voltage must be 6V plus 0.7V (to compensate for voltage across D1) plus 1.5V (for the dropout voltage), ie, the input voltage must be at least 2.2V higher than the output voltage.

Therefore, we need to apply 8.2V minimum to the input for regulation. This is the absolute minimum and to ensure correct regulation under varying loads, a 9V input to the supply would be ideal. Note also that any ripple on the input supply that drops below the required voltage will cause problems, since the supply will not be regulated during these low-going excursions.

Once you've connected the supply, it's just a matter of adjusting trimpot VR1 to set the required output voltage.

Finally, note that in some applications, you might want to replace VR1 with a fixed resistor (eg, if the resistance value you measure at VR1's setting is close to a standard fixed value). This has been catered for on the PCB – just replace VR1 with resistor R2 (shown dotted). SC

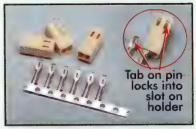
Making up the polarised header connector leads

You can buy ready-made header leads but they are not particularly easy to find. It's usually much quicker and cheaper to buy the bits and make up your own, even if it is fiddly!

The connector terminals are usually supplied in a strip, as shown at right – these need to be separated by either individually cutting them off or bending back and forth until they break off.

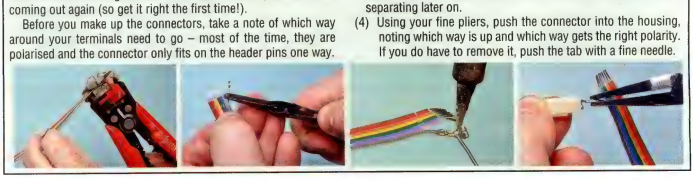
These terminals, when completed, slide into the connector housing and have a small tab which prevents them coming out again (so get it right the first time!).

Before you make up the connectors, take a note of which way around your terminals need to go – most of the time, they are polarised and the connector only fits on the header pins one way.



Making up the leads is not difficult but it is a bit fiddly. It's easiest to do one pin at a time.

(1) Strip all the ribbon lead ends for the number of connectors required – it's best done with a wire stripper to get them nice and even.
(2) Crimp the bare wires into the connector using a pair of fine pliers. Make sure no loose strands of wire are left out.
(3) Solder the wires in place. It's a belt'n'braces approach but it does ensure that you don't have any wires separating later on.
(4) Using your fine pliers, push the connector into the housing, noting which way is up and which way gets the right polarity. If you do have to remove it, push the tab with a fine needle.



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SERVICEMAN'S LOG

Repairing a damaged home alarm system

Dave Thompson*

Getting my home alarm system fixed when it was recently accidentally damaged proved to be a real challenge. This tale has more twists and turns than an Agatha Christie novel.

Items Covered This Month

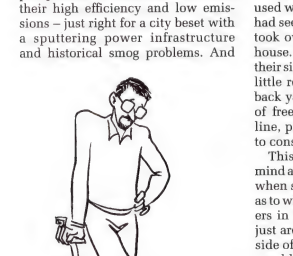
- Faulty home alarm system
- The obsolete A: drive
- dB Technologies Opera 210 powered loudspeaker system
- Fridge temperature control module

*Dave Thompson, runs PC Anytime in Christchurch, NZ.

For those who aren't aware, my home town of Christchurch gets mighty cold during the winter (which usually lasts about 11 months of the year). And this past winter has been especially harsh for those with quake-damaged homes missing a roof or sporting temporary walls made of industrial cling-film and tar-paper.

While our house escaped physical punishment, it does get cold, which is partly why Mrs Serviceman and I decided to install heat pumps this year. We've relied on a pellet fire for years but have lately fallen out of love with it due to the hassle of sourcing and lugging around heavy bags of fuel – not to mention the ever-growing expense of keeping it fed.

Power cuts notwithstanding, heat pumps seemed to be the best bet with their high efficiency and low emissions – just right for a city beset with a sputtering power infrastructure and historical smog problems. And so that's what we decided to do. We went with a large local company not only because of their reputation, but because for years Chris, the company's owner, and I trained at the same Aikido club.



~WE'VE RELIED ON A PELLET FIRE FOR YEARS...

Chris sent one of his staff around to give our place the once-over and work out where best to put the Fizter valves and flux capacitors. I simply followed him around and agreed with his recommendations because as you might have sussed by now, I know diddly-squat about AC systems.

A week later, the company's technicians installed two pumps and two inverters, which worked fantastically and lived up to all our expectations. However, we had a few minor niggles to sort out.

To begin with, the inverter units used were far larger than anything we had seen before and they pretty much took over the entire rear wall of our house. Not only were they ugly but their size and positioning ate into what little recreation room we had in our back yard. Then there were the gales of freezing air lashing our washing line, picnic table and back door area to consider.

This wasn't quite what we had in mind and Nina confirmed my thoughts when she asked the obvious question as to why they had installed the inverters in this particular spot instead of just around the corner on the "dead" side of the house, where there is only a seldom-traversed narrow strip of wasted space. I kicked myself for not cottoning-on to this beforehand but in my defence, I had no idea the things were going to eat up so much space.

We had absolutely no problems with the work itself though; the guys did a very tidy job but we felt that the end result just wasn't quite right.

I was just about to call and negotiate with Chris to have his team come back and move the inverter units to the side of the house when we discovered another problem: our alarm system was no longer working. To install one of the pumps, their electrician had to move one of the PIR sensors. However, he must have shorted something out because when we went to set the alarm, we discovered it was as dead as a dodo.

I made the call and Chris dropped everything and came straight around. He took one look and immediately agreed that the inverters were in the wrong place. In fact, he told me that he'd warned his salespeople and installer teams time and time again not to place the units anywhere near doorways (one metre from ours), clothes lines (about two metres) and patios (taking up most of ours).

No problem, he said, he'd get the guys to move them around the side of the house and as for the alarm, he'd get it all fixed. He also explained that the inverters were so big because they have to be these days to get the required efficiency out of them.

The installation team were back in a few days and had the inverters moved in a couple of hours. And as before, they did a very professional job. However, the alarm was proving a different story. Various electricians from Chris' company came around and had a go but in the end conceded it was beyond them. It would need a

technician to sort it out, so who better to tackle it than yours truly.

The alarm was completely dead, with no mains or battery back-up power evident. This pointed to the problem being a fuse or something just as obvious. Anyway, I squeezed into the roof-space and removed the alarm's front panel. The alarm box housed the main circuit board, power transformer, stand-by SLA battery and a veritable rat's nest of wiring. There were two standard fuses mounted on the circuit board, one of which was obviously blown.

I hoped it would be an easy fix and sure enough, with the fuse replaced and everything connected, the alarm beeped into life. I basked in the glow of achievement one gets from a job like that but unfortunately, that feeling soon evaporated when I saw the keypad showing a fault condition. The mains fault LED was flashing and this was accompanied by a periodic short beep, which I immediately recognised – each time the power failed after the larger earthquakes, the alarm system complained about going into battery back-up mode with just such a beep.

Back in the roof-space, I established that power was getting to the board OK and by checking various other points such as IC power pins, I soon confirmed that the correct voltages were present over most of the board. But there was still something was seriously wrong with it, even though in every other respect it worked perfectly.

Faced with an unfamiliar circuit and no service data, I chucked it in at that point and called the alarm people. I had reached the limit of my talents. My problems didn't end there though; it took many phone calls over a week and a half plus a threat to go to another monitoring company before their technician finally turned up. By that time, I'd put everything back the way I'd found it and watched as this guy did pretty much what I had done, replacing the fuse and measuring here and there before coming to much the same conclusion.

In the end, he said that the board was fried, although he also reckoned the external siren was shorted and that this was what had blown the fuse. He didn't sound too confident though and had to call his home-base several times to get codes to drive the alarm, something I could have helped him with if he'd asked as I had the quick-start manual.

Finally, after a bit more mucking about, he claimed that the alarm was too old and because there were no available spares, said he would have to replace the panel along with the keypads, sensors and sirens. I wasn't too keen on that idea, explaining it would be unfair to hit Chris for the cost of a completely new system. At that point, the technician offered to check his parts boxes for a secondhand circuit board and get in touch.

After waiting another week, I realised he wasn't going to call, so I did what any red-blooded Kiwi male would do and hit the web in search of one myself. Luck was with me because, almost miraculously, I found an identical circuit board up for auction, so I put in a minimal bid. In the end, I won the auction and it turned out the guy lived just around the corner. Within the hour I was checking out my new/old stock panel box with a virgin alarm mainboard and even a shiny new keypad thrown in for good measure.

Talk about good fortune! Now all I had to do was hope it would work.

My idea was to step through the old board's programming options, noting down the settings, and then program the new board the same way. It should then simply be a matter of "plug and go". After all, I'm a technician, so how hard could it be?

But first, I had to get the old board out. I carefully documented where everything went up in the roof-space and removed the board from the panel. I powered it up on my workbench and got stuck in. Almost instantly I hit an insurmountable wall; I needed the original installation code to go any further and given this is a top-secret pin code installers use to set up their alarms, I doubted I'd get it easily.

I tried everything I could think of, including the time-honoured "close your eyes and randomly hit numbers" method but nothing worked. Eventually, I was worked up enough to call the alarm company and demand someone tell me the code, my reasoning being it was my alarm bought and paid for and I had a right to know. They wouldn't budge though but they did offer to

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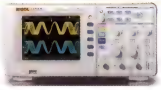

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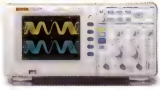

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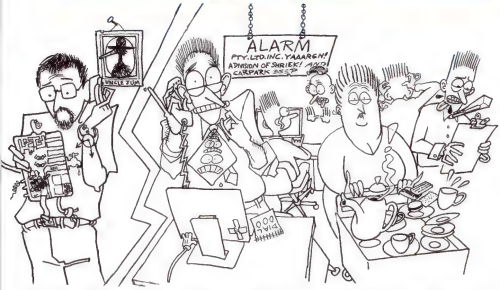
EMONA



send a technician out to unlock it at no charge, so I grudgingly agreed.

This was getting to be a real hassle but the technician was there soon enough, although he had no idea what the code was either. After 30 minutes of button pushing and cursing and repeated calls to his home-base, he cracked it. It turned out my unlock code had been superseded and was no longer used, which had the technician wondering aloud (with appropriate cursing) why head office didn't just give it to me in the first place.

Now that I had unrestricted access, I carefully stepped through 300-odd programming settings and noted them down on a handy sheet I had downloaded from the alarm manufacturer's website. I then swapped the boards over and repeated the procedure, this time entering the very same settings. However, some of them didn't make any sense and didn't match any known options.

I forged ahead anyway, then wired it all back in and powered it up. It worked but I was disappointed to discover that it didn't work as it should.

I was way out of my depth by this time and without help, that was it for me. I didn't want to wait until next morning to contact the alarm company so I hit the web but could find precious little information for my system.

However, while searching, I did find an excellent Aussie-run online forum, with different sections specialising in all types of technology. The security alarms section turned out to be a fantastic resource frequented by current and former professional security people eager to help, so I put my questions to them and received many suggestions as to what to do or look out for, including information only those in the game would likely know.

Unfortunately, none of their suggestions resolved my particular issue.

About the same time all this was happening, Chris got back in touch saying that one of his staff was a former alarm technician and was keen to have a look. He took one look at the alarm and said that his old workmate was the best man to talk to, so he gave him a quick call. He arrived 30 minutes later and between them they had it all going in 10 minutes.

They were both mildly surprised I had gotten as far as I had with it and one of them said that what had tripped me up was that the original installer had used several undocumented settings to make the alarm behave in ways it wasn't specifically designed for. That was why my recorded settings didn't make sense and it probably also explained why the first technician thought that the siren had shorted as well.

It just goes to show that even with all the available information on hand some things still need the specialist's magic touch. But as I say to all my clients, if you want to have a go and know you won't make things worse, go for it. The trick is in knowing when to pull the pin on your own abilities and not be too proud to ask for help.

As Dirty Harry said in Magnum Force, a "Man's got to know his limitations".

The obsolete A: drive

It wasn't that many years ago that the only means of storing our precious data was the floppy disk. Recent computer users may think of the relatively compact 3½-inch format when "floppy disk" is mentioned, while computer users of old will think of the much larger 5¼-inch model.

The floppy disk drive in a DOS-based or Windows-based computer was designated the "A" drive. However, some of the more expensive models sported two such drives, so there was a "B" drive as well.

The 5¼-inch model had a very satisfying method of ensuring that the disk was properly secured during the critical read/write process. This was achieved by the use of a locking handle, which had to be turned 90% in order to secure the disk, engage the drive head and activate the firmware. A big LED gave visual indication that something was definitely going on inside there somewhere, as if all the whirring and clicking didn't tell us already.

Not only were these devices and the accompanying disks a technical marvel in their day, they were also relatively inexpensive (compared to say, 8MB of memory or a 20MB hard drive) and revolutionised the way we stored data. However, there was a downside; users soon discovered that breathing, talking or sometimes even looking in the direction of the computer during the save process could cause data corruption, something users of early CD-writers will fondly remember. This usually meant that the disk had to be reformatted and the process repeated.

The disks themselves also turned out to be notoriously unreliable, usually failing at the worst possible times, such as when your master's thesis was ready to hand in, the figures for your tax audit were due or your publisher required the final proof of your latest novel. Data just seemed to fall off the disks, making storing anything on them a bit like a game of Russian roulette; you'd never know when you went to use the disk if it would cough

up all its secrets or not.

Actually, that's a little unfair. Compared to saving data from RAM onto a tape recorder, the floppy disk was a dream and compared to tape saving, it was quite fast. Saving anything to tape would often take at least 10 minutes and it would inevitably fail for the same reasons outlined above and need re-saving, while the same amount of data could be written to a 5¼-inch disk in a matter of seconds. And of course their reliability improved as time went on.

Further improvements in the technology eventually led to the development of the "compact" 3½-inch model that most people are familiar with today. This new format was not only much smaller but you could fit more onto the disk as well. Pick-up head technology also improved, increasing the read/write speed and the reliability and this made the 3½-inch format incredibly popular.

Solid-state thumb drives subsequently rendered floppy disks obsolete and the drives are no longer readily available except on the secondhand market.

Of course, where there is new technology there are stories of people getting into trouble with it. For example, I had a customer who came in complaining that he couldn't get a disk in the drive and sure enough, something was impeding the disk. A quick fish around with a pair of tweezers produced two credit cards and a rather angry client who'd only just cancelled them, thinking they'd been stolen. Apparently, client-junior had seen dad putting disks into the slot and decided that the cards seemed about the right fit.

Another client tried cutting down his old 5¼-inch disks and fitting them inside a 3½-inch disk case. He subsequently brought his tower in, claiming his floppy drive had stopped working. When I found out what he'd done, I told him he'd need a new one.

I heard of others who didn't bother fitting cut-down 5-¼ disks into the smaller case. Instead, they just trimmed them down until they fitted into the smaller drive!

Yet another client held the sliding metal protective cover on the disk open and cleaned the disk with methylated spirits, thinking it would help recover the data he could no longer read from the disk. It didn't.

The floppy disk changed the way we did things and gave ordinary computer users the ability to conveniently save their work and read it on another computer. It also gave some people a new way to stuff things up!

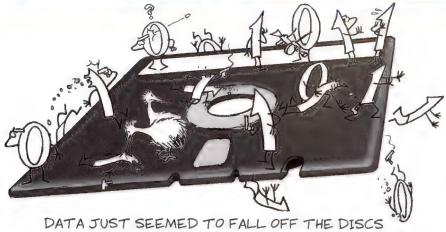
dB Technologies Opera 210

My next story comes from S. E. in Victoria and concerns an interesting manufacturing fault which eventually led to the failure of an amplifier module. Here's how he tells it . . .

The dB Technologies range of powered loudspeakers are a reasonably-priced cousin to the RCF-branded range. This particular unit definitely had the bean counters in charge of the design process because it used two LM3886 amplifier modules in bridge mode to provide the grunt for the bottom end instead of a "real amplifier".

The unit came from a music shop and was labelled "blows fuses", which is the usual description for almost any kind of failure I have found. After removing all the screws and extracting the amplifier chassis, the problem was immediately evident. One of the amplifier modules was missing part of the casing where it had blown apart and when this happens, it's a good idea to replace both as a matter of course.

Dismantling the chassis, de-soldering the old modules and soldering in the new ones is rather time-consuming



DATA JUST SEEMED TO FALL OFF THE DISCS
~MAKING STORING A BIT LIKE RUSSIAN ROULETTE

but the job was completed without incident. It was then that I noticed two Mosfets which were obviously part of the output stage of the amplifier. It's never too late to consult the schematic I thought, so after a quick look I realised that this amplifier was a variation of a class-H topology with two extra supply rails.

The two Mosfets (IRF540 N-channel and IRF9540 P-channel) sit between the inner and outer supply rails. They are normally off and only start to conduct when the output of the amplifier rises towards the inner rails. They then turn on and allow the output of the amplifier to swing towards the outer rails.

This technique reduces the power dissipated in the amplifier and keeps the modules within their defined safe operating area.

The Mosfets were checked with the multimeter and no shorts were evident, so I assumed they were fine. As a result, the amplifier was reassembled and switched on, which went without a hitch much to my relief. A sinewave signal was then fed into the input and a scope check showed a beautiful sinewave output, right up until clipping at the outer rails.

However, a voice inside was nagging at me to make some further checks on the amplifier and my suspicions proved to be correct. Something was not quite right with the operation of the class-H circuits and a quick check of the voltages on the Mosfets revealed that both were turned on hard. As a result, the amplifier was permanently operating with both outer rails applied instead of only using them when high power was needed.

I went back to the schematic to find out why. This is where the brain took a while to catch up. The Mosfets are only supposed to turn on when the output of the amplifier swings near those rails. However, at idle, the output of the amplifier was definitely at 0V.

At this stage, I decided to check to make sure the installed devices were in fact what they were supposed to be. And that's when I discovered the problem – the two Mosfets had been swapped and were in the wrong place!

The only logical explanation for this is that the mix-up occurred in the factory. But whatever the explanation, it was certainly the reason why the amplifier had failed so spectacularly. There was just too much voltage on the modules and they were operating outside their design specifications.

Refitting two new Mosfets in their correct locations fixed the problem.

Fridge temperature control

P. E. of Heathcote, Vic., recently had a control module in an expensive fridge/freezer fail. When he discovered that a spare module was no longer available, he decided to fix the faulty module himself. Here's his story . . .

Nineteen years ago, I purchased a 230/12V Trailblazer fridge/freezer for use in a 4X4 on desert trips. It subsequently served me extremely well and was capable of keeping about 50 litres of food at -18°C.

Unfortunately, on my last trip, the auxiliary battery terminal came loose, causing the Danfoss 102N3030 "black box" to overload and burn out. At the time, I was heading to the town in Queensland where Trailblazers are made, so thought I'd call in to buy a new "black box" while I was there. What could be easier?

It didn't turn out that way though. When I got there, they told me that the electronic control module was no longer available (the unit is 19 years old) and that even if it were, it would cost about $300. They also told me that the module is unserviceable but that I could have the fridge re-manufactured using later components at a cost of up to $1000. A new fridge is about $2000 (they *are* good units).

When I got home, I decided I would take a close look at this unserviceable module in detail. It came apart quite easily but the PCB was covered in a thin resin that was going to make things tricky. The fault itself was very obvious – a P50N06 Mosfet was burnt black, or at least, I assumed that it was a P50N06 since there were two more of that type which appeared undamaged.

I decided to try my luck at Jaycar and they ordered me in three Mosfets for $7.50. Hopefully, they would do the trick. My plan was to replace the damaged unit and keep the other two as spares.

The old Mosfet was fastened to its heatsink by a 2mm Allen key self-tapper. I didn't reuse this as I thought a nut and bolt would be more secure. I don't think silicone grease had been used originally but I decided it wouldn't hurt to use some, to help keep this vital part as cool as possible.

Having replaced the Mosfet, I decided to also replace the four electrolytic capacitors on the board. They'd been there for 19 years and often operated in very hot conditions. In addition, there are several contacts along one edge of the board which plug into the compressor unit. These were tightened, cleaned and sprayed with a small amount of WD40.

It was time for the smoke test and, much to my relief, the fridge started and operated without problems. All the new components were then fixed to the PCB using hot-melt glue, as the unit is subject to vibration on rough roads. All that remained then was to mount the black box back in its compartment and install a remote fuse so it can be easily checked when on the road.

In the end, the repair cost just $10 plus about three hours of my time, so it was definitely worth it. I'll be keeping a closer eye on the battery terminals from now on though. SC

Camping & Outdoors

TAKE ADVANTAGE OF THE SUN

Amorphous Solar Panels

These amorphous silicon panels have a strong aluminium frame and the cells are protected by a strong, clear glass window. They are long lasting and will maintain 80% of their performance rating, even after 20 years of use.

- 20 years limited warranty

From $19.95

Now New & Improved, includes protective plastic corners & battery clips

6V 1W	ZM-9020	$19.95
12V 2W	ZM-9024	$29.95
12V 4W	ZM-9026	$49.95
12V 10W	ZM-9030	$89.95
12V 15W	ZM-9045	$129.00
12V 40W	ZM-9034	$299.00

12V 2W Briefcase Solar Charger

Convenient brief case sized solar chargers for keeping a car battery topped up while on holidays. Three sizes for small, medium and large cars or 4WDs.

- Each terminates in a cigarette lighter plug or alligator clips.

From $29.95

2W Charger ZM-9036
WAS $39.95 **NOW** $29.95 **SAVE** $10.00
4W Charger ZM-9037
WAS $49.95 **NOW** $ 39.95 **SAVE** $10.00
7W Charger ZM-9038
WAS $79.95 **NOW** $59.95 **SAVE** $20.00

Solar Powered 3W LED Sensor Light

A fully self sustained lighting kit, perfect where mains power is unavailable. Uses high powered CREE® LED lights to provide a bright focused beam of light to illuminate driveways, backyards etc. A waterproof solar panel with a 5m lead is supplied to keep the rechargeable batteries topped up. The built-in PIR motion detector automatically turns the light on for 5 to 20 seconds (adjustable). Very easy to install.

- Battery: Ni-MH battery
- Mounting hardware included
- Solar light size: 95(L) x 240(H) x 137(D)mm
- Solar panel size: 140(L) x 198(H) x 66(D)mm

$99.00

SL-2707

Also available:
Solar Powered 2 x 3W LED Sensor Light
SL-2709 $129.00

SOLAR POWERED VENT EXTRACTOR

A completely self powered contained vent extractor for expelling odious smells, noxious gasses or preventing the buildup of mould in damp rooms. The fan will operate up to 24 hours on a fully charged battery and ideal for bathrooms, kitchens, offices, attics etc.

- Roof or wall mounting
- Built-in Rechargeable 1.2V 3000mAH Ni-MH battery
- Size: 210 x 240mm

$99.95

NEW

MP-4558

CAMPING ACCESSORIES

12V Camping Shower

All you need is a bucket of warm water and your vehicles' 12V battery. The 4.8m power cable plugs into a vehicles' cigarette lighter socket and a waterproof switch controls power to the pump. The shower comes with 2.1 metres of plastic tubing, pump, showerhead, hanging hook and a carry bag. Ideal for camping and 4WD.

$24.95

YS-2800

Rechargeable Air Pump

From party balloons and pool toys to larger air mattresses and rubber dinghies - this high-volume low-pressure rechargeable air pump will have the job done in no time. Recharged via mains power or car charger (included). Its portable cord-free operation makes this a must-have accessory for your beach and camping inflatables.

- Includes hose and two air nozzle fittings
- Mains adaptor (240VAC) and car charger (12VDC) included

$29.95 SAVE $10.00

GH-1119 WAS $39.95

12V Car Kettle

Simply plug into your cars cigarette lighter socket, mount to your cars interior and boil away. Holds up to 950ml and makes up to 4 cups of tea, coffee, soup or any other hot beverage.

- 2 cups, strainer and mounting bracket included
- Size: 235(H) x 95(Dia.)mm

$17.95

GH-1380

12V Portable Stove

Cooks, warms or reheats at up to 125°C. Deep lid design, with a case made from durable ABS plastic and carrying handles.

- Size: 265(L) x 180(W) x 155(H)mm

$49.95

YS-2808

SUMMER WATER FUN

30m Fluorescent Yellow Diving Head Torch

Equip yourself with the right gear when venturing into the depths. This head torch can be used up to 30m underwater and has an adjustable head strap. The fluorescent yellow is unmistakable in low-light caverns and shipwrecks.

- Burn time: 25 hrs (ON), 60hrs (flashing)
- 200 Lumens light output
- Uses 4 x AAA batteries included

$39.95

ST-3458

Diving Mask with Digital Camera 2GB

Strap on this diving mask with a built-in digital camera and take up to 2350 photos or 2 hours of video. Features tempered glass lenses, durable frame and a silicone mask gasket.

- Rated for 15m depth
- LED flash
- 5MP sensor
- USB 2.0
- 2GB internal memory
- 3 hour battery life

$89.00 SAVE $40.00

QC-3186 WAS $129.00

RGB LED FLEXIBLE STRIP LIGHTING KIT - 12VDC

A full RGB flexible LED lighting kit that contains everything you will need to set up your own colour changing strip lighting system. Simply connect the LED strip and power supply to the controller and away you go. The LED Strip has a self adhesive backing for easy installation. The remote control allows you to select from various colour changing modes or fixed colour modes.

- 5 metre length RGB flexible strip
- LEDs per metre: 30
- LED RGB panel controller
- 12VDC power supply

$149.00

NEW

SL-3958

WEATHER STATION/CLOCK/PHOTO FRAME

Keep tabs on the weather, the time and displays photos. A remote sensor sends weather data to the display unit, which provides temperature, humidity, trend and forecast information and also displays indoor temperature. Photos can be loaded by a host PC, via SD/MMC card or USB flash drive. Mains plugpack included.

- 12/24 hour clock with alarm
- Wall or desk mount
- Mains powered
- Dimensions: 200(W) x 150(H) x 30(D)mm

$129.00 SAVE $30.00

XC-0345 WAS $159.00

PERFECT FOR BBQ SETTING

Solar Rechargeable Candle

An ideal lighting solution for your next BBQ dinner or family gathering. Simply charge by exposing the solar panel on the bottom to sunlight, when darkness falls, turn it over and the LED candle will automatically turn on.

- No batteries required
- Size: 92(L) x 78(Dia.)mm

$14.95

ST-3925

Also available:
12 Piece LED Tealight Candle
ST-3921 $14.95

NEW

Solar Powered LED Ropelights

Put your party lights anywhere the sun shines. Mounts the solar cell to any flat surface and charges the built-in battery. When the sun goes down, your lights come on automatically and light the 100 red, amber and green LEDs with different flashing patterns that you select.

- 10m long
- Solar panel size: 148(W) x 105(H)mm

$19.95 SAVE $30.00

SL-2829 WAS $49.95

Limited stock
Not Available Online

Christmas Gift Ideas

NEW TOYS FOR THE BIG BOYS

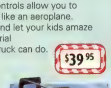
Flying Truck

Send this radio controlled truck racing down a track to pick up speed before it launches into the air. The advanced body design and controls allow you to easily control this flying truck like an aeroplane. Turn any road into a runway and let your kids amaze their friends with different aerial manoeuvres only this flying truck can do.

- Adjustable trim control
- 20 min charge for up to 5 minutes flying time
- Suitable for ages 8+
- Remote requires requires 6 x AA batteries (not included)
- Size: 210(L) x 113(W) x 127(H)mm

GT-3389

$39.95



Product art may vary

iPhone® Controlled Helicopter

This beautifully designed helicopter is operated through your iPhone® by connecting the infra-red dongle through the iPhone® earphones socket. Simply download the free application from the iTunes store and you are ready to start flying.

- Built in Gyroscope
- Steer by iPhone® tilt sensor
- Black, white and silver
- Compatible with iPhone® /iPad® or iPod Touch®
- USB Charging cable included
- 30 minutes recharge for about 5 min flight time
- Size: 135(L) x 40(W) x 80(H)mm

GT-3460

$79.95

iPhone® not included

TWO-PLAYER RC BUMPER CARS

High speed bumper vehicles designed for thrilling head to head RC battles. Knock the opposing rider off its vehicle by making contact with one of the bumper tabs located on both sides. Counter attack your opponent's bumper for a glorious victory!

- Includes 2 x vehicles & 2 x wireless remote controls
- Requires 10 x AAA batteries
- Suitable for ages 10+
- Vehicles 125mm long

GT-3698

$39.95

4-CH RC 4 ENGINE UFO

A four-engine, four-rotor flying widget. Each channel and motor on the craft is colour-coded so you can easily identify what makes it go where. It has a built-in rechargeable Li-ion battery that recharges from the remote unit. 20 minute charge gives about 5 minutes of flight time.

- Remote requires 6 x AA batteries
- Size: 230(Dia.)mm

GT-3782 WAS $69.95

$39.95 SAVE $30.00

INTERACTIVE MUSIC QUIZ

Test your family and friends music knowledge with this interactive music quiz! Game options include 'name that track', 'beat the intro', 'name the artist' and 'sing the next line'. Or mash up your own game - the possibilities are endless!

- Speaker console with four team buzzers and LCD points display
- Quizmaster controller with music start/stop button, points buttons, crowd sound effects, three music distortion buttons and volume control
- MP3 player (not included) connection to the Quizmaster controller
- Requires 3 x AA batteries
- Suitable for ages 8+

GE-4233 WAS $39.95

$24.95 SAVE $15.00

MINI SOLAR RACE CARS

Fun and functional mini solar race car kit with built-in electric motor. No glue required - simply snap all the pieces together. The sun or a 50W halogen globe powers both models.

- Size: 60(L)mm
- Suitable for ages 10+

Red GT-3755
Green GT-3756

WAS $12.95

$9.95 ea SAVE $3.00

SALT WATER FUEL CELL POWERED CAR

A simple, environmentally friendly fuel cell to power small electric car for hours of safe fun. All that you have to add is water and table spoon of salt! Includes 3 fuel cell sheets, non woven fabric separator and air cathode.

- Suitable for ages 8+
- Car measures: 75(L) x 40(W) x 18(H) mm

KJ-8921

Spare Fuel Cell Cartridge

KJ-8941 $4.95

$19.95

DECEMBER BONUS FREE Fuel Cell Catridge valued at $4.95

1:10 SCALE REMOTE CONTROL OFF-ROAD ELECTRIC CARS

These are serious 1:10 scale electric off-road remote control racing cars! Each is constructed around a lightweight hardened plastic chassis, and features front and rear fully adjustable independent suspension with oil-dampened shock absorbers, full-time shaft-driven 4WD with front and rear geared differentials, lightweight aluminium top plate for extra chassis strength, hi-speed steering servo, electronic speed controller (ESC) and hi-torque RC540 brushed motor. Complete with 7.2V 1800mAH Ni-MH rechargeable battery pack and mains charger. See website for full specifications.

- Controller require 8 x AA batteries
- Recommended for ages 12+

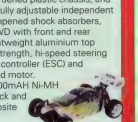
Buggy

GT-3670 WAS $229.00
NOW $199.00 SAVE $30.00

Monster Truck

GT-3672 WAS $249.00
NOW $209.00 SAVE $40.00

From $199.00 SAVE $30.00



HELICOPTER CLEARANCE

Helicopters shown below are priced to clear. Limited stock available - be quick.

Mini 2-Ch Apache IR Helicopter

Robust moulded plastic construction.

- 20 minute charge for about 10 minutes flying time
- Recharges directly from the remote unit
- Remote requires 6 x AA batteries
- Recommended for ages 10+
- Size: 160(L)mm approx.

GT-3273 WAS $29.95

$19.95 SAVE $10.00

Mini 3-Ch RC Helicopter

An entry-level chopper for the first time flier.

- 3 channel
- 20 minute charge gives about 10 minutes flying time
- Recharges directly from the remote unit
- Remote requires 6 x AA batteries
- Recommended for ages 8+
- Spare blade set **GT-3307** $9.95
- Size: 160(L)mm approx.

GT-3306

$29.95

Alloy Shark 3-Ch RC Helicopter

All aluminium airframe, fuselage and landing gear.

- 3 channel
- 45 minute charge for 10 minute flight time
- Remote requires 4 x AA batteries
- Plugpack charger included
- Recommended for ages 14+
- Size: 380(L)mm approx.

GT-3380 WAS $79.95

Limited Stock Not Available Online

$39.95 SAVE $40.00

Apache 3-Ch RC Attack Chopper

Built-in gyroscope.

- Remote requires 6 x AA batteries
- 70 minute charge for about 10 minute flying time
- Frequency: 27MHz
- Recommended for ages 10+
- Size: 310(L)mm approx.

GT-3382 WAS $89.95

Limited Stock Not Available Online

$49.95 SAVE $40.00

4-Ch RC Helicopter

Advanced helicopter. Elevation, yaw, pitch and bank.

- 4 channel
- Super light and extremely rigid aluminium frame
- Built-in gyroscope for stable flight
- 90 minute charge for 10 minute flight time
- Frequency: 2.4GHz
- Remote requires 6 x AA batteries
- Recommended for ages 10+
- Size: 360(L)mm

GT-3340 WAS $179.00

Limited Stock

$139.00 SAVE $40.00

www.jaycar.com.au

All Savings are based on Original RRP. Limited stock on sale items.

Jaycar Electronics
Better, More Technical

Christmas Gift Ideas

FOR HIM

USB Slide/Film Scanner

Convert your negatives and slides to digital images quickly and easily with this USB scanner. Images are scanned in about half a second for high-speed conversion and editing using the included Arcsoft Photoimpression software or one of many other image management programs.

- Colour or B&W film or slides
- Negative and slide holders included
- 1,800 dpi resolution
- USB powered
- Dimensions: 85(W) x 165(H) x 90(D)mm

XC-4881 WAS $74.00

$49.00 SAVE $25.00

4GB Digital Voice Recorder

With 4GB capacity and stereo capability, this recorder quickly record musical ideas in either High Quality, Long Play or Short Play and to play back MP3 tracks. Play back through headphones or the built-in speaker. Great for students and business meetings.

- Up to 1080 hours recording
- Supports MP3/WMA/ACT formats
- Built-in Li-ion battery
- USB cable, user manual, earphone, external mic
- Dimensions: 85(L) x 34(W) x 11(H)mm

XC-0383

$99.00

1080p Media Player with USB/SD/LAN ports

View your collection of downloaded movies or digital pictures on your TV easily. Just attach your USB hard drive or thumb drive with your movies or SD card from your digital camera and start watching.

- Video playback: Supports AVI/MP4, DIVX, XVID, MPEG1/2, RM, RMVB, DAT, MOV and VOB. Music playback: MP3, WAV, OGG & WMA audio formats
- HDMI, YPbPr (YUV component) and AV outputs
- Ethernet connectivity (UPnP)

XC-4204 WAS $139.00

$119.00 SAVE $20.00

3 SPEED TURNTABLE WITH SPEAKERS & AUDIO OUTPUT

Listen to vinyl collections directly from the unit with it's built-in speakers or connect directly to an external amplifier. Features a 3.5mm headphone jack for personal listening with adjustable bass control.

- 33/45/78 RPM
- Stereo amplifier
- Automatic stop
- Mains powered
- Dimensions: 350(L) x 310(D) x 130(H)mm

GE-4136 WAS $79.00

$69.00 SAVE $10.00

AM/FM WORLD BAND RECEIVER

A truly portable world radio covering AM/FM/SW bands with Phase Locked Loop (PLL) technology ensuring rock-steady, drift free reception even with weaker signals. An excellent radio that will perform well for years.
See website for full specs.

- Shortwave band from 2,300 - 7,500kHz & 9,200 - 22,000kHz
- Requires 2 x AA batteries
- Size: 120(W) x 75(H) x 30(D)mm

AR-1745

$59.95

ADVANCED 2W 38 CHANNEL UHF TRANSCEIVER WITH CTCSS

This high-quality 38Ch UHF transceiver provides a range up to 10km line-of-sight suiting many professional and leisure activities. Save battery power by switching to the low setting (500mW) for local communications. Includes rechargeable Li-ion battery and plugpack charger.

- CTCSS function
- Power output: 2W
- Hi/Lo power output
- Size: 120(L) x 57(W) x 35(H)mm

NOTE: CTCSS (Continuous Tone-Coded Squelch System) allows users on a shared channel to reduce interference from other users by filtering them out.

DC-1047 WAS $99.95

$79.95 SAVE $20.00

HI-FI STEREO BLUETOOTH® HEADSET

Multi-function headphones with Bluetooth® and hands-free profile with the ability to listen to MP3 music from a mobile phone or a PC. Crystal clear sound using digital sound processing and built in CVC (clear voice capture) to eliminate noise while talking. Features a full cup headset with soft touch leatherette finish and rechargeable Li-Po battery. Perfect for the commuter, student, or multi-tasker.

- Multipoint Support: 2 connections simultaneously
- Supports A2DP, AVRCP, headset, hands free profile
- Low battery LED and audio indication
- Working range: up to 10 metres

AA-2082

Great for Commuters

$79.95

NEW

FOR THE YOUNG MINDS

Solar Eco-House Kit

Fun to build eco-house kit that will introduce your child to an eco-friendly concepts in an entertaining way. The house has it own solar panel and a windmill to supply free power to the lighting & sound circuits.

- Requires 2 x AA batteries for non-solar operation
- Recommended for ages 8+
- Approximately 160mm square

KJ-8924 WAS $29.95

$19.95 SAVE $10.00

Buy both for $35 SAVE $24.90

Solar Powered / Dynamo Robot Kit

Build your own solar powered robot. Robot moves forward and reverse. Supplied with a hand cranked dynamo for alternative power source.

- No batteries needed
- Recommended for ages 8+

KJ-8821
WAS $29.95

$19.95 SAVE $10.00

INDOOR DESK THERMOMETERS

Handy desk or table-top thermometers. Measures degrees Celsius with hi and low memory. Tilting bail for standing on desk purposes. Battery included.

- Range: -20 - 50°C
- Size: 64(W) x 72(H) x 18(D)mm

Indoor
QM-7316 WAS $5.95 NOW $3.95 SAVE $2.00

Indoor/Outdoor
QM-7318 WAS $6.95 NOW $3.95 SAVE $3.00

PILLOW SPEAKERS

A safe and convenient alternative to headphones or earphones whilst listening to music in bed. Simply plug in an MP3 player, iPod® or radio and place into a pillow case. No batteries required. Perfect for children and adults alike.

- Includes 1m lead with 3.5mm stereo plug
- Impedance: 16 ohm @ 1kHz
- Maximum power: 0.6W

AS-3029

NEW

$9.95

FOR HER

Countdown Timer

Use it for cooking, parking, exercising, studying or even timing the kids on the computer. Water resistant, easy to use, has a memory setting for frequently used values and the buzzer alerts you to when your time is up.

- Countdown range 99 hours 99 minutes 99 seconds
- 2 x AAA batteries included
- Dimensions: 88(W) x 130(H) x 22(D)mm

XC-0271 WAS $24.95

$19.95 SAVE $5.00

3kg Kitchen Scales

Easy to use and will measure up to 3kg. Features tare function to disregard the weight of a mixing bowl and only weigh the ingredients. Weighs in both metric and imperial.

- Resolution: 1g
- Requires 2 x AA batteries
- Auto power off
- Dimensions: 145(W) x 210(L)mm

QM-7257 WAS $34.95

$29.95 SAVE $5.00

149 Piece Pink Tool Set

Finished in bright pink, the kit contains a hammer, long nose pliers, multigrips, tape measure, screwdrivers, shifting spanner, shears, driver with 20 bits, 8-piece Allen key set, 6 jewellers' screwdrivers plus an assortment of nails, screws and other fasteners. An easy to follow How-to booklet is included on each tool and common household tasks.

- Case measures: 250(W) x 322(H) x 65(D)mm

TD-2075 WAS $49.95

$39.95 SAVE $10.00

MERRY CHRISTMAS

FROM JAYCAR

VIEW THE JAYCAR CATALOGUE ON YOUR iPAD®

Exciting news for iPad® users! The complete 508-page 2011 Jaycar Catalogue is now available on iTunes for FREE. Just search for "Jaycar" in iTunes® or visit our website for link.

NEW

USB BUSINESS CARD SCANNER

Save your business card contacts directly to an Outlook or Outlook Express address book. Scan a business card and the included Optical Character Recognition software will extract text from the business card and categorises it in to 13 different fields. Powered by USB and uses a 1.3MP sensor. Unit comes with a mini USB lead.

$79.95

- Scans single or double sided business cards
- Supports multiple languages
- Size: 120(L) x 70(W) x 20(D)mm

XC-4908

Laptop not included

ANDROID SMART TV MEDIA PLAYER

Powered by the Android operating system this smart TV media player will add a new dimension of interactivity to your plasma or old CRT. You can access all your favourite internet sites, install and run Android apps, watch just about any movie from your media collection, play games, facebook, twitter, msn, youtube etc. Just plug in a USB hard drive loaded with movies or connect to a shared drive on your Windows/Mac/Linux machine and start watching your favourite movies with ease. See website for specifications.

$199.00

- OS: Android 2.2
- Resolutions: 420p, 576i, 576p 720p, 1080i, 1080p
- Dimensions: 210(L) x 171(W) x 35(H)mm

XC-4208

Due early December

G-FORCE METER KIT

Measure the g-forces on your vehicle and it's occupants during your next lap around the race circuit, or use this kit to encourage smoother driving to save petrol and reduce wear & tear. Forces (+/- 2g) are displayed on the 4-digit LED display. Also use it to measure g-forces on a boat crashing over waves or on a theme park thrill ride. Kit includes PCB with pre-mounted SMD component, pre-programmed microcontroller and all onboard electronic components.

$49.95

- Requires 2 x AA batteries
- PCB: 100(L) x 44(W)mm

KC-5504

NOTE: We supply the PCB with the SMD component already mounted on the board to save time and frustration.

2KW SINE WAVE INVERTER GENERATOR

Petrol powered and differs from cheaper units, due to the engine, which is built to the same design as the market leading Japanese brands, and drives a DC alternator. The inverter then converts the DC to a stable pure sine wave 230VAC, suitable for appliances including sensitive electronics. No matter what the load is on the generator, the output remains at 230VAC 50Hz. Compact, the petrol motor keeps engine speed in line with the load, reducing noise and increasing fuel efficiency.

$899.00

- Electric start & recoil start
- 7L fuel capacity (approx 6.5hr run time)
- 2x 230/240V GPO power outlets
- 12V 8.3A vehicle battery charger output
- LED indicators for output, overload and oil level

MG-4502

NOTE: Not available in all stores but can be ordered. Call your nearest store for details

4 CHANNEL DVR KIT WITH 4 OUTDOOR COLOUR CAMERAS

This DVR kit comes with 500GB of storage for over 300 hours of continuous video recording, as well as four cameras to cover all of the important areas. Supports backup via USB drive and live recording can be initiated manually or pre-programmed via Smartphone®/Phone® (via installed app) or the internet, and log into your system from anywhere and view live and recorded footage.

$499.00 SAVE $100

DVR:

- Video compression: H.264
- Alarm notification via email
- Automatic recovery after power failure
- PTZ compatibility via RS-485 port
- Mains power supply included
- Size: 300(L) x 210(W) x 50(H)mm

Camera:

- Outdoor weatherproof enclosure
- Infrared LEDs for day/night operation
- Sensor: 350TV Lines colour CMOS
- Cable length: 18m (video & power in one)
- Size: 85(D) x 58(D)x 38mm

Limited Stock Not Available Online

QV-3026 WAS $599.00

CD PLAYER WITH USB/SD ENCODING MUSIC BOX

Digitally encode your old CD collection straight to SD card or memory stick. Also record directly from a USB drive to SD card or vice versa. Features AM/FM digital tuner, blue back light LCD, alarm clock with sleep and snooze function.

$79.00 SAVE $20.00

- CD / CD-R, RW / MP3-CD playback
- Built-in amplifier and stereo speakers
- Requires 2 x AAA batteries
- Dimensions: 250(W) x 204(D) x 85(H)mm

GE-4138 WAS $99.00

Also available: Cassette Player with USB/SD Encoding with amplified playback **GE-4139** NOW $79.00 SAVE $20

3CHANNEL 27MHZ RC HELICOPTER

All aluminium airframe chopper complete with a built-in gyroscope for more stable flight and dual blade design for easy control. Comes with a lightweight Li-Po battery that provides up to 8 minutes of flight time from a 60 min charge.

$69.95

- Mains power charger included
- Remote requires 4 x AA batteries
- Size: 370(L)mm

GT-3350

Great Gift Idea

More helicopters in-store

PORTABLE CASSETTE TAPE TO MP3 ENCODER WITH PC CONNECTION

Dust off your old cassette tapes and rescue your retro-chic 80's and 90's music collection with this tape to MP3 encoder. Simply install the included software to your computer, plug in the encoder via USB and you're ready to digitally convert, restore and archive all your precious cassette music. USB cable, instruction manual and software included.

$69.95

- Converts to MP3 or WAV file formats with track recognition
- Powered from USB port or 2 x AA batteries (not included)
- Size: 93(L) x 118(W) x 32(D)mm

GE-4071

ULTRASONIC ANTIFOULING UNITS

We've been selling the D.I.Y kit successfully for over a year now, and the growing consensus is that ultrasonic antifouling systems appear to work very well. The special frequencies seriously deter marine growth of the various organisms that choose to use your boat as a home, reducing the frequency of slipping for messy, expensive and dangerous antifouling treatment. These completely manufactured units are straight forward to install. Power is supplied by 12VDC and a low voltage cut-out feature is also included, which protects the boat's batteries from being over discharged. Each unit includes a control box (5m lead) and transducers (10m lead each), and a comprehensive installation & instruction manual. More details and specification can be found on our website.

- 2 years warranty

Two versions available:

Dual Output, suitable for vessels up to 14m (45ft)

YS-5600 $899.00

Quad Output, suitable for vessels up to 20m (65ft)

YS-5602 $1199.00

NOTE: Larger vessels can simply use multiple units. Twin hull vessels will require double the recommendations above.

From $899.00

Check our website for Christmas Trading Hours

To order call **1800 022 888** **www.jaycar.com.au**

Prices valid from 24/12/2011 to 24/12/2011. Limited stock on sale items. No rainchecks.

Jaycar Electronics

Better, More Technical

Automotive

CAR VIDEO EVENT RECORDER

Capture the accident and playback later. This handy device is automatically activated by the built-in 3-axis G sensor that responds to a sudden braking or a collision. It starts recording the event to an SD card (16GB stores up to 5hrs - card not included). Simply mounts onto the windscreen like a GPS unit.

- 120° wide-angle camera with IR LEDs
- Playback includes Google Maps location
- Video resolution: 640 x 480 @ 30 fps
- Real time clock stamp
- Video output for external monitor
- Size: 92(W) x 80(H)mm

QV-3798 WAS $249.00

$199.00 SAVE $50.00

2.4GHZ REAR VIEW MIRROR REVERSING CAMERA

Incorporates a reversing camera that transmits video signals via the 2.4GHz band to the monitor which can be mounted internally or externally. The monitor fits securely over your existing rear view mirror and can be quickly removed when needed.

- 3.5" LCD colour screen
- Range: up to 80m
- Dimensions: 280(L) x 95(H) x 26(D)mm

QM-3795 WAS $199.00

$149.00 SAVE $50.00

REVERSING CAMERA WITH SENSORS AND 3" LCD MONITOR

This complete reversing system includes a flush mount camera, 3" LCD screen and 4 sensor ultrasonic distance system. The screen shows the camera vision together with sensor status and parking assistance lines. The distance to sensed objects appears on the screen and an audible alarm sounds if you get too close to anything.

- Power: 12VDC
- On Screen Display menu
- Flush mount camera included
- Shock, vibration and water resistant camera
- Dimensions: Screen: 93(W) x 62(H) x 24(D)mm Camera: 33(L) x 20(Dia.)mm

LR-8870

$249.00

CAR VOLTAGE METER / IN-OUT THERMOMETER / CLOCK

The unit plugs into car's cigarette lighter socket and gives an accurate measurement of the battery voltage, displays inside and outside temperature and the time.

- EL blue backlit display
- Size: 145(W) x 34(H) x 32(D)mm

XC-0116 WAS $45.00

$35.00 SAVE $10.00

MULTIFUNCTION 200W INVERTER

Housed in a tough rubberised case, ideal power accessory for your next camping, fishing or 4WD adventure. In addition to a 200W modified sinewave inverter, it provides a USB outlet, an LED work light and two 12V cigarette lighter sockets. 12VDC connection is via cigarette lighter plug.

- Size: 230(W) x 180(H) x 62(D)mm

MI-5103

$69.95

TOUCH SCREEN LCD MONITOR WITH USB

Touch screen capabilities enables use with a laptop/PC, games console and endless other VGA operating devices. Use it to control a computer or any other USB compatible device. The monitor can be mounted either on the bracket or flush mounted with cradle. Software and adaptor cables included.

- Size: 178(W) x 122(H) x 30(D)mm

QM-3744 WAS $249.00

$199.00 SAVE $50.00

IN-DASH CD/MP3/DAB+/ FM RADIO

In addition to DAB+, you also get FM and MP3 playback through just about any source you could think of - USB, SD or MMC card or CD. It also has a built-in 4 x 20WRMS amplifier, so all you'll need to add is speakers. The ideal replacement for that tired factory-fitted music machine.

- Flip-down detachable panel with colour LCD
- SD/MMC card, USB and AUX inputs
- CD/MP3/WMA, CD-R/RW playback
- 4 x 20W RMS output
- 4-band EQ (Classic, pop, rock, flat)
- 18FM/12AM presets
- Mounting depth: 180mm

QM-3783 Not available in NZ

NEW

$299.00

BLUETOOTH® HANDS FREE CAR KIT

Avoid the risk involved with using your mobile handset whilst driving by using this simple Bluetooth® hands free car kit. It has a built-in speaker and microphone, features echo cancellation for clear calls, and even has adjustable volume. A cost effective solution for hands free mobile phone use and much cheaper than getting fined!

- Input voltage: 9-26VDC
- Dimensions: 56(Dia.) x 25(H)mm

AR-3121

NEW

$29.95

Great Gift Idea

MINIMAXIMITE CONTROLLER KIT

Refer to Silicon Chip November 2011

A versatile and intelligent controller to interface with your creations, such as home automation. Features 20 configurable digital/analog I/O ports, 128K RAM and 256KB flash memory to hold your program and data. Design and test in MMBasic over a USB link from your PC, then disconnect the PC and the programs continue to operate. Alternatively, hard wire a PC monitor, keyboard, SD card reader and amplified speaker to work independent of a PC. Requires 2.3 - 3.6V DC (2 x AA or use plugpack MP-3310). Kit supplied with PCB, pre-programmed and pre-soldered micro, and electronic components.

- PCB: 78 x 38mm

KC-5505

NOTE: We supply all of the surface mounted components already pre-soldered to save you time and frustration.

NEW

$49.95

DIGITAL AUDIO DELAY KIT

Refer to Silicon Chip December 2011

Corrects sound and picture synchronisation ("lip sync") between your modern TV and home theatre system. Features an adjustable delay from 20 to 1500ms in 10ms steps, and handles Dolby Digital AC3, DTS and linear PCM audio with sampling rate of up to 48kHz. Connections include digital S/PDIF and optical Toslink connections, and digital processing means there is no audio degradation. Kit includes PCB with overlay and pre-soldered SMD IC, enclosure with machined panels, and electronic components.

- 9-12VDC power supply required - use MP-3146
- Universal IR remote required - use AR-1729
- PCB: 103 x 118mm

KC-5506

NEW

$99.95

YOUR LOCAL JAYCAR STORE - Free Call Orders: 1800 022 888

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Annual dates of new products in this flyer were confirmed at the time of print. Occasionally these dates change unexpectedly. Please ring your local store to check stock details. **Prices valid from 24th November to 24th December 2011.** All savings are based on original RRP

Head Office
320 Victoria Road, Rydalmere NSW 2116
Ph: (02) 8832 3100 Fax: (02) 8832 3169

Online Orders
Website: www.jaycar.com.au
Email: techstore@jaycar.com.au

Jaycar Electronics
Better, More Technical

ARDUINO MODULES

Light Sensor Module

This silicon light sensor outputs a voltage proportional to incoming light. Perfect for measuring light levels both indoors and out, security sensing and human feedback like waving a hand over the sensor.

- +/-60° field of view
- Supply voltage: 3.0 to 5.5VDC

$9.95

XC-4228

Due early December

Temperature Sensor Module

Sprinkle these around your house to collect temperature data using your Arduino. This 1-wire bus temperature sensor module is easy to connect and use. You can even daisy-chain several together on the same wire. 0.5°C accuracy and fast response.

- -55 to +125°C temperature range
- +/-0.5°C accuracy
- Selectable 9 or 12 bit precision
- Arduino compatible library and examples support
- Unique device ID coded into every sensor
- Two sets of header connections to allow easy daisy-chaining

$16.95

XC-4230 Due early December

3-Axis Accelerometer Module

Easy to use 3-axis accelerometer that provides separate outputs for X, Y, and Z. Very simple to connect to an Arduino or other microcontroller using analog inputs, and easy to read the values into your program or circuit directly.

- Selectable +/-1.5g and +/-6g ranges
- Freefall-detection 0gi output
- Built-in 3.3V regulator with 5V-safe I/O lines

$19.95

XC-4226

Humidity & Temperature Sensor Module

Measure temperature and relative humidity using a simple interface that requires just three wires to the sensor: GND, power, and data. Supported by an Arduino library that makes it very easy to read values into your project, so with a single I/O line from your microcontroller you can read both temperature and humidity.

- -4°C to +125°C temperature range with +/-0.5°C accuracy
- 0-100% relative humidity with 2-5% accuracy
- 3 to 5V operation
- Blue power LED

$19.95

XC-4246

Due early December

Sound & Buzzer Module

This versatile piezo-element module can be used for both input or output! It can be used as a noise-maker driven by your microcontroller for audible feedback of events, and it can also be used as a knock-detector input to sense events and react to them. Includes a built-in 1M resistor to allow the piezo element to detect shocks.

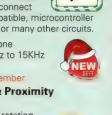
- Frequency response 0-20KHz, peak resonant frequency: 4KHz +/-500Hz
- Sound pressure level at 10cm: 75dB (min)
- 1 to 28V rated voltage (3 to 5V typical)

$9.95

XC-4232 Due early December

Microphone Sound Input Module

Give your project ears with this sound response and sound pressure level sensing module. An integrated dual signal amplifier converts the sound to separate channels for pulse and frequency measurement, and sound volume level. Designed to connect straight to an Arduino compatible, microcontroller Analog to Digital converter or many other circuits.



- Omnidirectional microphone
- Frequency response 60Hz to 15KHz
- Sensitivity -40dB typical

$9.95

XC-4236 Due early December

Hall Effect Magnetic & Proximity Sensor Module

Sense magnetic presence, rotating wheels and magnets, door and arm sensors, and anything else magnetic nearby this sensor.

- Green "triggered" LED for easy setup and use
- Output turns on at 40 Gauss (4mT) and turns off at 30 Gauss (3mT)
- 2.5 to 5.5V operation

$9.95

XC-4242

Due early December

Full Colour RGB LED Module

Includes a bright RGB LED on the top of the board and a WS2801 constant-current, addressable, multi-channel LED driver on the back. This smart module can be daisy-chained, so you can connect a number of these together in a string and drive each of the module colours individually from your microcontroller. The WS2801 includes its own built-in PWM outputs.

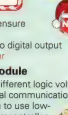
$9.95

- 3.3 to 5V operation
- Constant current controller

XC-4234 Due early December

N-MOSFET Driver & Output Module

This high-power N-MOSFET module lets you switch high-current loads using a tiny microcontroller. Works brilliantly for automotive projects such as switching high-power 12V lights and high wattage LEDs.



- Maximum 60V / 20A switched load
- Multiple connection headers for high-current wiring

$6.95

- Built-in pulldown resistor to ensure output is off by default
- Drive directly from an Arduino digital output

XC-4244 Due early December

Logic Level Converter Module

This module easily connects different logic voltage levels together for bi-directional communication on up to 4 channels, allowing you to use low-voltage sensors with a 5V microcontroller.

- 4 bi-directional channels
- Easily connect 3.3V sensors and devices to 5V microcontrollers
- Pass-through GND connection

$6.95

XC-4238 Due early December

Shift Register Expansion Module

Use this shift register expansion module to drive up to 8 devices using just 3 pins on your microcontroller. They can also be daisy-chained together to drive 16 channels or more.

- 8 output channels per module
- 2 to 6V operation
- Blue power LED

$6.95

XC-4240 Due early December

BREADBOARDS

Breadboard Jumper Kit

This kit consists of 70 pieces of single core sturdy wire which has been stripped on each end and bent at right angles.

- Specifically made for breadboards
- 5 packs each of 14 different length

$11.95

PB-8850

Breadboard

Simply a combination of 2 x distribution strip and 1 x terminal strip.

- 840 tie points
- 200 distribution holes
- 640 terminal holes
- Size: 65(W) x 175(L)mm

$19.95

PB-8814

POWER-OVER-ETHERNET REGULATOR

This regulator module fits onto the EtherTen or EtherMega to make them compatible with commercial 48V Power-over-Ethernet switches. It includes built-in smarts to communicate with the switch and negotiate a power rating for the device, then uses a switch-mode regulator to efficiently drop the 48V supplied via the LAN cable down to 7.5V for use by the Arduino compatible board.

- Implements the official 802.3af Power-over-Ethernet standard
- 48VDC in, 7.5VDC out
- 12.5W maximum power rating

$29.95

XC-4252

8 CHANNEL POE MIDSPAN INJECTOR

Power up to 4 EtherTen's or EtherMega's with DC from a low-cost pluggack across your home or office network cables. This takes all the hard work out of cutting and hacking ethernet cables to power remote boards, it isolates and powers the correct wires automatically.

- 4 channels of input/output jacks
- 4 EtherTen or EtherMega boards can be connected directly and powered by standard network cables on the output side Commercial
- Power-over-Ethernet sources are now required
- Blue power LED
- Mounting holes

$26.95

XC-4254

Arduino Development Kits & Modules

ARDUINO DEVELOPMENT KITS

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs (includes Jaycar stepper motors). Arduino projects can be stand-alone, or they can be communicated with software running on your computer. These Arduino development kits are 100% Arduino compatible. Designed in Australia and supported with tutorials, guides, a forum and more at www.freetronics.com. A very active worldwide community and resources are available with many projects, ideas and programs available to freely use.

"Eleven" Arduino-compatible development board

An incredibly versatile programmable board for creating projects. Easily programmed using the free Arduino IDE development environment, and can be connected into your project using a variety of analog and digital inputs and outputs. Accepts expansion shields and can be interfaced with our wide range of sensor, actuator, light, and sound modules.

- ATmega328P MCU running at 16MHz
- 14 digital I/O lines (6 with PWM support)
- 8 analog inputs

XC-4210 $39.95

EtherMega, Mega sized Arduino 2560 compatible with Ethernet

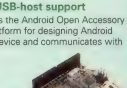
The ultimate network-connected Arduino-compatible board: combining an ATmega2560 MCU, onboard Ethernet, a USB-serial converter, a microSD card slot for storing gigabytes of web server content or data, Power-over-Ethernet support, and even an onboard switchmode voltage regulator so it can run on up to 28VDC without overheating.

- ATmega2560 MCU running at 16MHz, large Flash memory
- 10/100base-T Ethernet built in
- 54 digital I/O lines
- 16 analog inputs
- MicroSD memory card slot
- Prototyping area
- Switchmode power supply

XC-4256 $119.00

USBDroid, Arduino-compatible with USB-host support

This special Arduino-compatible board supports the Android Open Accessory Development Kit, which is Google's official platform for designing Android accessories. Plugs straight into your Android device and communicates with it via USB. Includes a built-in phone charger.



- ATmega328P MCU running at 16MHz
- USB host controller chip
- Phone charging circuit built in
- 14 digital I/O lines (6 with PWM support)
- 8 analog inputs
- MicroSD memory card slot

XC-4222 $69.95

EtherTen, Arduino-compatible with Ethernet

This Arduino-compatible development board includes onboard Ethernet, a USB-serial converter, a microSD card slot for storing gigabytes of web server content or data, and even Power-over-Ethernet support.

- ATmega328P MCU running at 16MHz
- 10/100base-T Ethernet built in
- Used as a web server, remote monitoring and control, home automation projects
- 14 digital I/O lines (6 with PWM support)
- 8 analog inputs

XC-4216 $69.95

POWER REGULATOR 28V (SWITCHMODE)

This regulator is a high tech switchmode supply with a selectable 5V or 7VDC output. The input voltage range of 6 to 28VDC is very flexible and it will not overheat at higher input voltages like the 7805 and other linear regulators may.

- Up to 1A output current at selectable 5V or 7VDC output voltage
- Can be used in any project as a high current low temperature power supply
- Can also be used for the EtherTen and EtherMega Power-over-Ethernet for efficient switchmode supply remote powering
- Blue power LED
- 0.1" pitch standard header pads

XC-4258 $19.95

PROTOSHIELD SHORT

A dedicated short version prototyping shield for EtherTen and EtherMega. This special prototyping shield is designed to fit neatly behind the RJ45 Ethernet jack, allowing you to stack your Ethernet-based projects right on top with standard headers.

- Pads available to fit a reset button
- Gold-plated surface for maximum durability

XC-4248 $4.95

PROTOSHIELD BASIC

A prototyping shield for the Eleven (XC-4210) and USBDroid (XC-4222). Provides plenty of space to add parts to suit any project, keeping everything neat and self-contained. Includes dedicated space to fit a power LED and supply decoupling capacitor.

- Gold-plated surface

XC-4214 $4.45

RECEIVER SHIELD 433MHz

This receiver shield lets you intercept 433MHz OOK/ASK signals, decoding them in software on your Arduino. All the Arduino headers are broken out to solder pads, and GND and 5V rails are provided for convenience.

- Reset button
- Blue "power" LED
- Red and green user-defined LEDs
- Gold-plated surface
- 433.92MHz tuned frequency

XC-4220 $29.95

LCD & KEYPAD SHIELD

Handy 16-character by 2-line display ready to plug straight in to your Arduino, with a software-controllable backlight and 5 buttons for user input. The display is set behind the shield for a low profile appearance and it includes panel mounting screw holes in the corners.

- 2 rows of 16 characters
- Supported by a driver library
- Software-controlled backlight
- Reset button
- Dimensions: 85(W) x 54(H) x 12(D)mm (24mm including header pins)

XC-4218 $29.95

TERMINAL SHIELD

A special prototyping shield for the Eleven (XC-4210) and USBDroid (XC-4222) that provides handy screw terminals on both edges for easy and secure connection.

- Power LED
- 3 user-definable LEDs: red, green, and blue
- Stackable headers
- Gold-plated surface

XC-4224 $16.95

GETTING STARTED WITH ARDUINO

This book explains what Arduino is, how it works and what you can do with it. It also includes a project to build, complete with how to write the code to make it work.

- Softcover, 118 pages. 216 x 140mm

BM-7130 $23.95

LARGE DOT MATRIX DISPLAY PANEL

A huge dot matrix LED panel to connect to Eleven, EtherTen and more! This large, bright 512 LED matrix panel has on-board controller circuitry designed to make it easy to use straight from your board. Clocks, status displays, graphics readouts and all kinds of impressive display projects are ready to create with this display's features.

- 32 x 16 high brightness Red LEDs (512 LEDs total) on a 10mm pitch
- 5V operation
- Viewable over 12 metres away
- Tough plastic frame
- Controller IC's on board, simple clocked data interface
- Arduino compatible library, graphics functions and example support

XC-4250 $39.95 Due early December

STACKABLE HEADER SET

The perfect accessory to the ProtoShield Basic (XC-4214), Pro, and vero type boards when connecting to your Arduino compatible project. Stackable headers have female sockets on the top side and male pins underneath.

- Gold flash 0.1" pitch quality stackable headers

HM-3207 $2.95

SECURE YOUR HOME

Intelligent 10 Sector Alarm Panel LA-5368

The most advanced version of our 10 zone alarm controllers. Boasting an impressive range of features above our standard alarm systems, this alarm panel gives you everything required for advanced alarm installations.

LA-5369

Standard features include support for up to four individual named keypads at a maximum range of 100m from the controller, four access levels of user codes with flexibility to program any zone as security, PA, fire or 24 hour tamper. Advanced features include more programming flexibility during installation and support for optional accessories. As this panel is designed with the flexibility to suit the requirements of many different installations, it is supplied as a control panel only.

LA-5368

$149.00

Suitable accessories - sold separately:

LED Keypad	LA-5561	$49.95
LCD Keypad	LA-5563	$69.95
GSM Dialler Module	LA-5369	$299.00
Wireless Sensor Adaptor	LA-5367	$69.95
12V 1.3Ah Backup Battery	SB-2480	$19.95

DVR Kit with 2 x Colour Cameras

Suited to small surveillance installations, this 4 channel systems can store over 150 hours of video on the internal 320GB HDD. View the recorded video in an indexed event log via a computer or external monitor. Complete with weather resistant IR cameras, cables, remote control and mains adaptors.

DVR: Limited Stock Not Available Online
- 4 x camera inputs
- 1 x composite video output
- MJPEG compression
- SATA hard drive interface

Camera:
- CMOS sensor, 350TV lines.
- Inbuilt infrared illumination for day/night operation
- Spare camera available **QC-3239** $59.95

$349.00 SAVE $150

QV-3020 WAS $499.00

Keypad Shed Alarm

Simple and effective shed or garage alarm. Consisting of a keypad, single reed switch for a door or window and 5m of cable for easy DIY installation. Used as an instant alarm or as a door chime to announce entry. Powered by a single 9V battery.

- Size: 162(H) x 86(W) x 32(D)mm

$19.95 SAVE $10.00

LA-5214 WAS $29.95

2.4GHz DIGITAL WIRELESS AUDIO BABY MONITOR

NEW

Listen to your baby from another room up to 50m away. The baby unit features a dock to recharge the receiver, night light with optional movement activation, programmable room temperature alert and handy pre-programmed lullabies to settle baby to sleep. The parent unit has a talk button key so you can talk to the baby as if you are in the room. Units are both mains or battery powered (3 x AAA required).

- 2.4GHz for clear, interference free transmission
- Includes 2 x power supply
- Size Baby unit: 98(H) x 103(W) x 44(D)mm
  Parent unit: 125(H) x 60(W) x 20(D)mm

$69.95

QC-3261

Vibration/Shock Sensor

A modern designed alarm vibration or shock sensor that has a wide dynamic range with high/low sensitivity settings. Lightweight, fast, easy to install and can be mounted to wood, steel, glass, and concrete. Includes latching and non latching modes plus a red LED indicator. See website for full specs.

- Selectable one or two pulses
- Size: 27(L) x 22(W) x 87(H)mm

LA-5071

$34.95

Also available: Intelligent Shock Sensor **LA-5073** $44.95

MOTION ACTIVATED TIME LAPSE HD CAMERA

Takes photos whenever it detects movement and creates a time lapse video to playback later on a PC. Perfect to put at the front door or secured areas to see which uninvited guests visited, etc. Once the PIR detects movement it will capture 30 frames in 30 seconds and store that video onto the included 2GB SD card. Supplied with mounting holder, suction holder and 4 x AA batteries.

$249.00

- 1280 x 720 resolution (AVI format)
- Field of view: 61 degrees
- Detection angle: 98 degrees
- Detection distance: 4m
- Size: 160(H) x 108(W) x 57(D)mm

QC-8032 Product colour may vary

12V PHOTOELECTRIC SMOKE DETECTOR

Ideal for permanent wiring in boats, caravans, motor-homes etc. This unit only draws 5mA from a 12V source. Fitted with NO and NC contacts to trigger an external alarm. Supplied with test and reset buttons, mounting hardware, and screws etc.

$19.95 SAVE $5.00

- Mount: Ceiling
- Range: 20m squared
- Sensor: I.R. Photodiode Sensor Type PC II or III
- Size: 110(Dia.) x 58(H)mm

LA-5045 WAS $24.95

DUMMY IR CAMERA

This dummy camera looks like the real thing - it has genuine-looking IR LEDs and a real LED that adds to the illusion. Add a couple of warning signs and the baddies will never know the difference.

- Requires 2 x AA batteries
- Mounting hardware included
- Size: 175(L) x 85(Dia.)mm

$19.95 SAVE $5.00

LA-5325 WAS $24.95

CCTV WARNING SIGN

NEW

Prominent warning sign for CCTV or dummy surveillance applications. Made from acrylic for durability.

- Size: 300(W) x 210(H)mm

LA-5114

$14.95

Also available: Surveillance Warning Sign 300 x 300mm

LA-5115 $14.95

Solar Powered Mini Window Alarms

A cost-effective and simple security measure. Peel the backing from the self-adhesive mount and position on the inside of a window or door. The solar cell keeps the built-in battery charged and if triggered, the very loud alarm sounds.

- Warning sticker included
- Size: 70(W) x 82(H) x 8(D)mm

Buy both for $30 SAVE $9.90

Glass Breakage/Vibration Window Alarm LA-5003 $19.95
Magnetic Entry Alarm LA-5005 $19.95

SLIMLINE COLOUR 7" LCD VIDEO DOOR PHONE

Great for screening visitors without even having to come to your door. Supplied with a high-resolution infrared CCD camera and 7" full colour LCD display. Integrates an intercom function for a bi-directional interference free conversation. Easy to install, super slim design makes it great for any modern home!

$199.00

- Mains power supply included
- Camera resolution: 380TV lines
- Monitor dimensions: 235(L) x 155(H) x 19(D)mm
- Camera dimensions: 100(L) x 134(H) x 45(D)mm

QC-3608

PROTECT YOUR CAR

Steelmate Entry Level Car Alarm with Voice Function

An affordable car alarm that features voice feedback on alarm status and operational parameters such as open doors etc. Other features include boot release button, valet mode, and emergency override.

$79.00 SAVE $20.00

- Includes electronic black box controller, shock sensor, ignition cutout relay, speaker siren, wiring looms, bonnet pin switch, car charger for the remote controls, extra circuits for fuel and ignition cutout, 2 x code hopping remote control units with a built in torch
- Spare remote available separately **LA-9004** $37.95

LA-9003 WAS $99.00

Six-Tone Car Alarm with Back-Up Battery

This compact siren has a rechargeable back-up battery pack mounted inside the unit, if the wires are cut by a thief, the siren will sound and the only way to disable the unit is to turn it off with a key. Internal batteries are kept on trickle charge so they are always fully charged.

- Power: 20W
- Voltage: 12VDC
- Supplied with 2 keys
- Size: 67(L) x 59(W) x 70(H)mm

$14.95 SAVE $10.00

LA-8912 WAS $24.95

12V Auto Strobe Light

Perfect for adding a visual deterrent to your car alarm. Supplied with two flasher lenses (red & blue) and all required mounting hardware.

- Size: only 60mm including mounting bracket

$9.95 SAVE $3.00

ST-3150 WAS $12.95

The clones are coming. . .

THE ALTERNATIVE Maximite WORLD

The Maximite world is growing. As we mentioned last month in our miniMaximite story, the Maximite has been cloned a number of times, so now there is a range of alternatives for you to choose from. To help you in this choice we gathered a number of these to test along with some expansion boards that might help you connect the Maximite to the rest of the world.

By Geoff Graham

We start with the DuinoMite. It is a Maximite clone manufactured in Bulgaria by Olimex and sold in Australia by Dontronics. The idea was to make a Maximite-compatible computer that is also compatible with the Arduino connector format – quite a tall order. Olimex has managed to make it work, albeit with a number of compromises.

The DuinoMite is actually a range of three boards consisting of a mini, standard and mega version with every option that you can think of. When we first saw them we mentally dubbed them baby bear, mother bear and father bear (of Goldilocks fame).

The samples we reviewed were pre-production but we understand that the final products will be quite similar.

The Maximite should be familiar to most SILICON CHIP readers but perhaps not the Arduino standard. The Arduino is a small single-board computer developed in Italy. It is generally based on an 8-bit Atmel AVR microcontroller and is an open design that others can easily modify if they wish.

The two standout features of the Arduino are an easy-to-use development environment (based on the C language) and a universal connector that allows the board to be connected to a variety of interchangeable add-on modules. In Arduino-speak these are known as "shields".

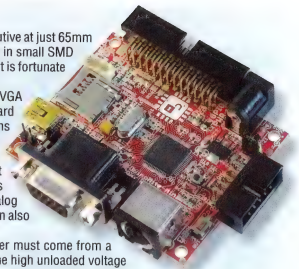
The success of the Arduino has caused an explosion in the number of available add-on shields. You can now purchase a shield with almost any function you care to imagine including networking, GPS, wireless, music and more. The DuinoMite range from Olimex seeks to capitalise on this wealth of products by providing the Maximite with an Arduino-compatible connector.

All the boards in the range also implement a UEXT connector. UEXT is another standard for connecting pre-built, add-on boards. This standard was invented by Olimex who understandably have the widest range including an I/O board with relays, GPS, LCD, Ethernet and wireless networking.

However, you do need to be careful when selecting a UEXT board as some require special software. For example, the WiFi board requires you to implement the TCP/IP protocol stack in software and that is simply not possible in MMBasic.

These comments apply to the Arduino shields as well. This is because some of them require the Arduino development environment (based on the C programming language) to make them work. Also, many shields come with a demonstration program (again written in C) but that is not much help with the DuinoMite range which is programmed in MMBasic, the same as the Maximite.

DuinoMite-Mini



The DuinoMite-Mini is the "baby bear" of the three and it is definitely diminutive at just 65mm x 75mm. The board is studded with connectors on all four sides and covered in small SMD components. It would be virtually impossible to hand-solder such a board, so it is fortunate that it comes fully assembled and tested as do all the boards in the range.

This board is possibly the closest to the Maximite in its facilities. It has a VGA and keyboard connector, 26-pin external I/O connector, USB and an SD card socket. The last two are the miniature versions and for most people this means that they will have to purchase a micro SD card. These are cheap enough, so that is not a problem.

The DuinoMite-Mini does not have an Arduino-compatible connector but you can purchase the DuinoMite-shield which adds this feature. Dontronics also have a number of other Maximite/Arduino conversion boards in their catalog which achieve the same purpose but come in a kit. Presumably any of these can also be used to add Arduino compatibility to the standard Maximite as well.

One thing to watch out for when using the DuinoMite-Mini is that its power must come from a 5V regulated power pack. Don't use the more common unregulated type as the high unloaded voltage from these will overheat the onboard voltage regulator and may cause damage.

Perhaps the greatest feature of the DuinoMite-Mini is its price: fully assembled and tested for just over AU$40, including GST and delivery within Australia. It represents amazing value, especially when compared to the alternative Maximite kit of parts at almost $90 (to be fair, this does include a case).

The DuinoMite range is certainly feature-packed. In addition to the Arduino and UEXT connectors, some models include battery backup (with an integrated battery charger), a real-time clock, RS-232 interface, CAN interface and proper connectors for sound and composite video. The actual features on offer vary from model to model so check the separate panels for details.

To fit the additional features into the DuinoMite, the designers were forced to make a number of compromises compared to the Maximite.

The first is that the DuinoMite will require a custom version of MMBasic with its own bootloader and serial port driver. This is not so bad as the MMBasic language is open source and can be modified by anyone (subject to conditions) but it does mean that this version will lag behind the "official" releases and is dependent on the supplier integrating their unique features into each new release.

A more significant compromise in the design of these boards is that the signals on the I/O connectors share functions with many other areas of the board.

For example, Maximite I/O pins 8, 9 and 10 (Arduino D11, D12 and D13) are also used to communicate with the SD card so they are unavailable if you plan to use the SD card for storage.

Presumably Olimex will add commands to MMBasic to switch between the two uses for these pins but that does not help if you wish to simultaneously use the SD card and all of the I/O pins.

Another example is Maximite pin 20 (Arduino D9) which is also used as the VGA vertical sync and to drive the yellow LED.

This sharing means that this I/O pin will not available if you are planning to use the VGA output and by being connected to the LED, it means that it will be difficult to use that pin for other functions anyway.

We counted nine I/O pins that are compromised in some way. This means that depending on how you intend to use the I/O pins and your technical expertise in getting around these complications, the DuinoMite will have much less than the normal twenty I/O pins to work with.

In addition to this, the functions of the I/O pins have been mixed around from the Maximite standard. For example, pin 8 should be capable of measuring voltage but in the DuinoMite it cannot. However, you do get another counting input.

The overall effect is that you will need to do a lot of research before you can use the I/O connectors in a project and if you change your mind (for example, to use the VGA display) your design and program might also have to change.

You are also in a world of your own that is different from other Maximite users and you will not be able to easily exchange programs that use the I/O connectors.

For users planning to use the Arduino connector, this mixup might be a little easier as the SD card signals on D11, D12 and D13 match the common use for these pins (SPI interface).

However, you will still lose the use of the SD card and have difficulties with some of the other I/O pins. The main complication here is that many Arduino shields rely on special software modules written in C and they will not run on the DuinoMite.

Because of the unusual features of the I/O connectors, the quality of the documentation supplied by the manufacturer will be paramount.

Tracing the circuit diagrams is difficult and understanding the interactions with other parts of the DuinoMite is near impossible so a clear explanation will be a life saver.

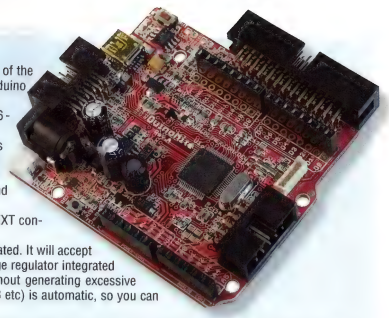
Great value

The DuinoMite range is not a replacement for the Maximite. By design it is a different product with its own set of strengths and weaknesses. It is similar to the Maximite in some ways and different in many others

The Mini version would make an excellent purchase if you were looking for a basic Maximite-like computer and did not want to do much with the

. . . continued on P64

DuinoMite (Standard)



The DuinoMite (standard version) is the middle version of the three boards and is more orientated towards providing Arduino compatibility.

Along with an Arduino connector it has a Maximite style 26-pin I/O connector and a 10-pin expansion connector.

The board does not have VGA or keyboard connectors but you can add these using the DuinoMite-IO board which plugs into the 10-pin expansion connector. This expansion board provides connectors for VGA, composite video, sound (both RCA and 3.5mm socket) and a PS2 keyboard.

Along with the others in the range this version has a UEXT connector, mini USB connector and a micro SD card socket.

The power supply on this board is much more sophisticated. It will accept an external input of 9 to 30V and it uses a switching voltage regulator integrated onto the board to supply the lower voltages required without generating excessive heat. Switching between the power sources (external, USB etc) is automatic, so you can say goodbye to messing about with jumpers.

As a bonus this board includes a charger for a Lithium Polymer battery and it will automatically switch to that on power failure. This means that adding battery backup to the DuinoMite simply involves plugging in a battery pack. You cannot get it much easier than that.

The DuinoMite is priced the same as the DuinoMite-Mini but don't forget that you will need to buy the expansion board if you want access to the video and keyboard interfaces.

DuinoMite-Mega

This is the "daddy bear" of the range. It does not attempt to keep a small footprint and it offers a veritable feast of features including all the attributes of the previous two boards.

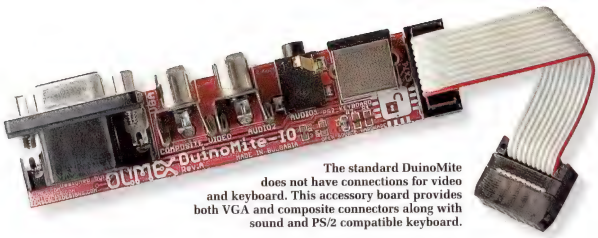
You have connectors for VGA and composite video, keyboard, sound (RCA and 3.5mm), Maximite-style I/O, Arduino-style I/O, USB, micro SD card and two UEXT connectors.

The DuinoMite-Mega adds a couple more features including a CAN networking connector and RS232 driver and connector. MMBasic already supports the serial protocol used by RS232 so that feature should work out of the box. However the CAN protocol is currently not supported and for this feature to be of use the manufacturer will need to add support for MMBasic.

Olimex will sell you a laser-cut box for the DuinoMite-Mega so you can package it in a case to protect it and make it look more like a real computer. This is useful as it allows you to move it around and treat it like a normal gadget without fear of causing an accidental short on the PCB.

All boards in the range (including the maxi version) have a 32.768Hz crystal connected to the PIC32 processor. This can be used to keep accurate time when the PIC32 chip is in one of its low power sleep modes. This feature does not have a battery backup so it will require an external Lithium Polymer battery (as described above) and modifications to MMBasic to be of any use.

The value of this and other features will depend on the sensible integration of them into MMBasic and this is where we will have to wait and see – our pre-production samples were running a preliminary implementation of MMBasic which did not support these features.



The standard DuinoMite does not have connections for video and keyboard. This accessory board provides both VGA and composite connectors along with sound and PS/2 compatible keyboard.

I/O connectors. You can connect it to a VGA display, keyboard and power supply and be up and running with MMBasic straight away. For the price it is unbeatable in this role.

To use these boards for more than this you will need to be technically orientated and prepared to dig through the circuit diagrams and technical details to put it to good use. If you do this you will find a powerful and versatile computer board with many handy features.

We were impressed with the DuinoMite range. They are well made, offer exceptional value and they provide a host of additional features. But if you are a typical user who wants to build their own computer and experiment with programming in BASIC, don't forget the standard Maximite. It is well documented and supported and it just works with far less complications.

By the time you read this the DuinoMite range should be available for purchase from **http://dontronics.com** and other online shops. The manufacturer's website is at **www.olimex.com**

The UBW32

There are times where you will need a lot of external I/O pins, for example, building an automated centipede demonstration! Seriously, there are times where you will need more than 20 pins and also, perhaps, where you want a simple plug-in module like the mini Maximite described last month but you do not wish to build your own.

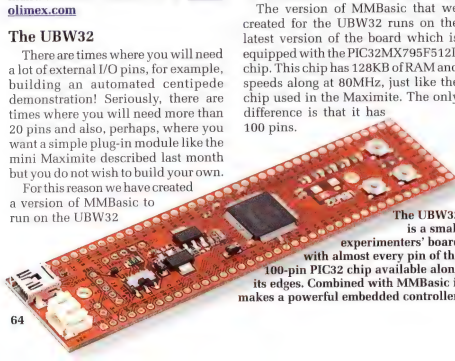
For this reason we have created a version of MMBasic to run on the UBW32 experimenter's board. Running on this board MMBasic can control no less than fifty I/O pins. That is a lot and should satisfy almost any I/O hungry application.

The UBW32 itself is a small, fully assembled and tested board which uses the 100-pin version of the PIC32 chip. At just 3cm wide and 11cm long it is more like a large IC than a computer board. You would normally solder header pins along the edges to make it into a general purpose plug-in module which can be used on a breadboard or motherboard.

The main communication with the UBW32 is via a mini USB connector mounted on the board. Using this you can load firmware and interact with the running program. Other than this there are just a few components on the board – the PIC32, a couple of voltage regulators, some LEDs and three push buttons.

The UBW32 makes a reasonably cost-effective embedded controller which is ideal for adding intelligence to your own creation, similar to the mini Maximite described last month.

The version of MMBasic that we created for the UBW32 runs on the latest version of the board which is equipped with the PIC32MX795F512L chip. This chip has 128KB of RAM and speeds along at 80MHz, just like the chip used in the Maximite. The only difference is that it has 100 pins.



The UBW32 is a small experimenters' board with almost every pin of the 100-pin PIC32 chip available along its edges. Combined with MMBasic it makes a powerful embedded controller.

Other than supporting the large number of I/O pins the UBW32 version of MMBasic is the same as the standard MMBasic running on the Maximite. You have the internal flash drive A:, the ability to attach a video monitor, keyboard, SD card and so on.

We even wrote a full user manual describing how to use the UBW32 with MMBasic and that, along with the firmware can be downloaded from the Silicon Chip website or the author's website at **http://geoffg.net/ubw32.html**

You load MMBasic onto the UBW32 using the standard UBW32 bootloader which is provided by its creator - so you do not need a programmer or anything special. Then, when you cycle the power, it will start up running MMBasic, just like the Maximite.

The UBW32 costs less than $50 and you can purchase it from **http://dontronics.com** and other on line shops. The developer has his own website where you can download the bootloader and other support material: **www.schmalzhaus.com/UBW32** Updates to MMBasic for the UBW32 will be released at the same time as Maximite updates and can be downloaded from **http://geoffg.net/ubw32.html**

Hamfield expansion boards

Hamfield are a small company who were quick to realise the potential of the Maximite when it was introduced and have since built up a good range of expansion boards designed to plug into the Maximite's 26 pin I/O connector.

Their current range consists of seven boards which provide features such as isolation and input protection, output buffering and RS-232 outputs. A particularly neat product is one that provides a serial to Ethernet capability which, amongst other things, will

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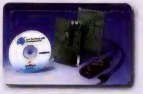

Low Pin Count USB Development Kit (DV164126)

Family	Flash Program Memory (KB)	Pins	USB Type	Sleep Current (nA)	Sleep with Watchdog Timer (nA)	Sleep with Real-Time Clock (nA)
PIC18F14K50	8-16	20	Device	24	450	790
PIC18F46J50	16-64	28-44	Device	13	813	813
PIC24FJ64GB004	32-64	28-44	OTG, Dual Role, Embedded Host, Device	20	220	520

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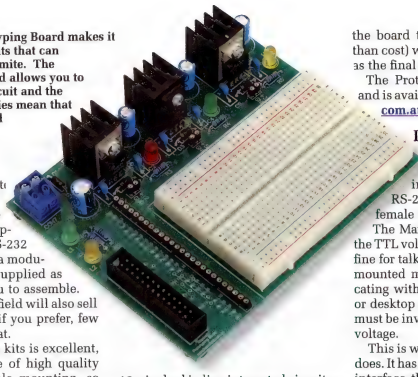


The Hamfield Prototyping Board makes it easy to test out circuits that can interface to the Maximite. The solderless breadboard allows you to assemble a small circuit and the built-in power supplies mean that you will not overload the Maximite.

allow your Maximite to send emails.

We reviewed three products – a prototyping board, a dual RS-232 interface board and a modular hub. These are supplied as a kit of parts for you to assemble. Commendably Hamfield will also sell you the bare board if you prefer, few suppliers will do that.

The quality of the kits is excellent, the components are of high quality and are through-hole mounting, so the kits should go together easily in under an hour. Some documentation is included with the kit and they even provide a CD with high resolution circuit diagrams and other information.

About the only issue is that due to a mix up in the early days of the Maximite the Hamfield 26-pin I/O connectors are reversed compared to that used on the Maximite.

Their recommended solution is to unsolder the connector on the Maximite and replace it with a different one. This is something we definitely **do not** recommend as you will almost certainly damage the PCB while doing this. A much better solution is to make up an interconnecting cable that is reversed at one end.

It has been over six months since this issue was discovered but Hamfield are still designing new boards with an incompatible connector.

Their documentation includes a one page defence of this action but it ignores the plight of the user. It would much better if the boards were simply designed to match an unmodified Maximite or were supplied with a cable that corrected the issue.

Prototyping board

The Hamfield prototyping board is intended to help the user experiment with small circuits attached to the Maximite.

It has three power supplies (12V, 5V and 3.3V) and a solderless breadboard with 30 rows capable of taking four 16-pin dual in line integrated circuits.

The three power supplies are derived from an external 15V power supply. Each regulator has a substantial heatsink so you could use them to power devices such as relays and solenoids.

This is preferable to using the Maximite's internal power supply which has a limited capability.

All 26 pins from the Maximite I/O are brought out onto a pin strip and can then be connected to the breadboard using standard jumpers, some of which are included in the kit. This arrangement allows you to quickly assemble and test a small circuit.

When you have your circuit working it would be easy to transfer it to a PCB or prototyping stripboard and then use the prototyping board for something else. Due to the solid construction of the board there is no reason (other than cost) why you could not use that as the final circuit.

The Prototyping Board costs $40 and is available from **www.hamfield.com.au**

Dual RS-232 board

This board takes the Maximite's two serial interfaces and adds two RS-232 driver chips and DB9 female connectors.

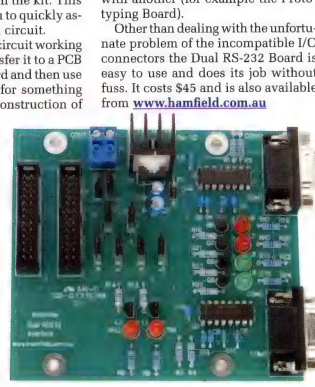
The Maximite's serial output is at the TTL voltage level (0 to 3V) which is fine for talking to other chips or board mounted modules but for communicating with devices such as a printer or desktop computer the signal levels must be inverted and at a much higher voltage.

This is what the Dual RS-232 Board does. It has a driver chip for each serial interface that inverts the signal and generates the required voltage levels (±12V) to match the RS-232 standard. A normal DB9 connector then enables you to connect to the external device.

Jumpers allow you to select the power source (external or Maximite) and which signals are used. The board also includes LEDs for each signal line, which is handy as sorting out RS-232 communication problems can be a frustrating experience.

A second 26 pin I/O connector allows you to daisy chain this board with another (for example the Prototyping Board).

Other than dealing with the unfortunate problem of the incompatible I/O connectors the Dual RS-232 Board is easy to use and does its job without fuss. It costs $45 and is also available from **www.hamfield.com.au**



This Dual RS-232 board makes it easy to use the Maximite serial interfaces with equipment that requires signals levels specified by the RS-232 standard. This board includes the drivers and the connectors that enable you to to connect the Maximite many devices including other computers, test equipment or a printer.

What Are Readers Using the Maximite For?

In the months since the Maximite kit has become available many experimenters have been busy putting it to work and we thought that readers might take inspiration from some of these projects.

In-car status display

The photograph below was provided by John Gerrard who uses the Maximite to generate a status display for his car.

The display panel was originally used with an in-car PC but with a press of a button, John can switch to the Maximite video output and check temperatures, pressures and more. Lest you are concerned, the manifold temperature is not correct – the sensor was not installed when this photo was taken.

This photograph was provided by SILICON CHIP reader John Gerrard, who uses the Maximite to generate a status display for his car, showing important temperatures and pressures.

Boiler and heater control

Peter Caffall-Davis of Hyder in Alaska has a project underway to use the Maximite to control his boiler and heating system.

The system includes a state of the art wood fired boiler that uses forced air for complete combustion; the system is so efficient that it even burns the smoke from the wood! The hot water from the boiler is circulated to a radiator and a fan takes that heat and distributes it inside the house.

Pete will use the Maximite to monitor the temperatures in the boiler's water jacket and inside the house. Based on these readings his program will control the blowers, water circulation pumps and fans.

Amongst other things this project gives readers from the hotter parts of our world an idea of the effort that goes into keeping comfortable in Alaska. If you want to see where Pete lives type 55°55'N 130°1'40"W into Google Earth and then tilt the view until you can see the horizon then rotate horizontally. The scenery is stunning.

Other interesting projects

Other Maximite projects that people have in progress include using it to control a Rohde and Schwartz ESMC communications receiver, a wind/solar power controller with data logging, a data logger recording the parameters of a Plasmatronics PL20 solar regulator and a super accurate GPS clock with LCD display and alarm outputs. And they are just the applications we've heard about – given the volume of sales, there are bount to be plenty more!

Family affair: not one but three Maximites!

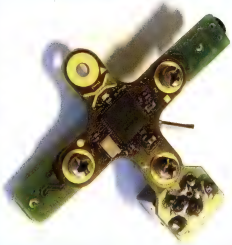
When Leo Simpson and Ross Tester visited Mater Maria College recently, they were not overly surprised to find one of the year nine students, Alex, with a completed (and operational) Maximite.

But they were somewhat taken aback when he told them that this was the second Maximite he had built – "the other one is at home controlling and monitoring things in the house".

He then went on to tell them that his year-eight sister had also successfully built her own Maximite, mainly because "she was always wanting to use mine, right when it was in the middle of doing things!"

Maximite in Estonia

The photo below shows what must be the smallest Maximite in the world. It was built by Antti Lukats in Estonia and is based on the CRUVI concept which includes a range of bolt on input/output modules which can connect to the legs of the Maximite.



Don't look too closely at the photograph as it is an early prototype but Antti is planning to start production of a more polished version soon. Unfortunately for the rest of us it will only be available in Estonia (initially anyway).

Along with the rest of the CRUVI range the Maximite version will be used in nearly all Estonian schools to teach electronics and computer technology. The concept has also been entered in the country's national Brainhunt competition and Antti is confident of winning a prize.

You can see the CRUVI version of the Maximite in action on YouTube running a Morse code program written by Reg Gauci in Australia. Point your browser to: www.youtube.com/user/JukuJaJuhan#p/a/u/1/LUMnO5p-fjg

It is tiny! SC

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions will be paid for at standard rates. All submissions should include full name, address & phone number.

Model train controller uses PIC and a full-bridge motor driver IC

This model railway train controller is based on a PICAXE18M2 microcontroller and an ST Micro L6203 full-bridge motor driver IC. Its features include speed regulation, simulated inertia (momentum), reversing, infrared remote control, over-current protection, derailment warning and low-speed starting.

It also uses high-frequency PWM (pulse width modulation) control for quiet motor operation.

It is designed for HO/OO gauge locomotives such as those made by Athearn. These have 5-pole, skew-wound motors with twin flywheels. It should work with similar motors as long as they have flywheels and sufficient back-EMF.

The L6203 contains four N-channel Mosfets in a full bridge configuration, ie, one high-side driver and one low-side driver for each rail. It runs off 12-48V and can pass up to 4A RMS. It's controlled via three logic-level inputs: a low/high input for each half-bridge plus a shared enable pin which, if driven low, turns off all four Mosfets. These can be pulsed at frequencies in excess of 100kHz.

The L6203 also contains cross-conduction prevention logic which prevents current "shoot-through" when switching. This is similar to the "dead-time" feature in some switching circuits. It also has a 13.5V reference voltage generator (not used in this circuit) and over-temperature shut-down. And it has separate power and logic grounds, to enable low-side current sensing with an external shunt resistor.

When the ENABLE (pin 11) and IN1 (pins 5) inputs are high and IN2 (pin 7) is low, OUT1 (pin 3) is pulled high (to Vs, pin 2) and OUT2 is pulled low (to SENSE, pin 10). This runs the motor in one direction. If IN1 is low and IN2 is high, OUT1 goes low and OUT2 goes high, running the motor in the opposite direction.

If IN1 and IN2 are in the same state (low or high), both outputs are at the same voltage and the motor brakes. If ENABLE is taken low, both tracks are disconnected from the supplies and the motor coasts. By "chopping" the IN1 and IN2 signals at a specific frequency (15kHz in this circuit), the average voltage applied to the motor can be varied and thereby the loco's speed.

The two 10nF capacitors connected between each output and the corresponding BOOTS (bootstrap) pin are used by the internal charge pump to generate the voltage necessary to turn the high-side Mosfets on.

While IC2 contains internal ground clamp diodes for each output, these are relatively slow and this results in higher dissipation in the chip. So Schottky diodes D3 & D4 are connected in parallel with the internal diodes and their lower forward voltage and fast switching makes the circuit more efficient while providing more effective clamping.

A snubber, comprising a 22nF capacitor and 10Ω series resistor is connected between the outputs. This limits the rate of change in the voltage across the rails, reducing electromagnetic interference (EMI) and cleaning up the back-EMF waveform. The back-EMF spikes on each rail are averaged using a pair of 10kΩ resistors, so that a positive spike on either rail can be sensed.

This is then low-pass filtered using a 10nF capacitor which has a parallel 22kΩ resistor to discharge it (also reducing the sensed back-EMF amplitude). Schottky diode D5 and the 10nF capacitor and 10MΩ resistor at its cathode form a peak-hold circuit. A positive back-EMF spike forward-biases D5 and charges the capacitor which then discharges through its parallel resistor. Micro IC1 can read its amplitude at pin 11 (input B.5) using its internal analog-to-digital converter (ADC).

Allan Doust is this month's winner of a Peak Atlas Test Instrument

Back-EMF feedback is used for speed regulation. The micro adjusts the motor drive duty cycle to keep the back-EMF amplitude constant for a given speed setting. It controls the bridge through output pins C.6, B.3 and B.6 (pins 15, 9 & 12 respectively) which connect to the ENABLE, IN1 and IN2 inputs of IC2.

To improve the linearity of the back-EMF measurement, the micro holds NPN transistor Q1 on for most of the time, driven by output B.4 (pin 10). This keeps the 10nF capacitor at IC1's pin 11 discharged. When the micro wants to measure the back-EMF it turns Q1 off, allowing the capacitor to charge for a certain period before sampling the voltage across it. This improves measurement linearity.

An over-current condition is detected by measuring the voltage across the 0.1Ω resistor from IC2's SENSE terminal (pin 10) to ground, using the same ADC. All current flowing across the tracks also flows through this resistor. A low-pass RC filter (10kΩ and 100nF) suppresses voltage spikes and if the measurement exceeds 0.1V (>1A motor current), power is cut, the piezo buzzer sounds and the two LEDs flash. Moving the speed control to neutral resets it.

This buzzer is driven directly from the C.7 output of IC1 (pin 16) while the LEDs are driven from outputs B.0 and B.1 (pins 6 & 7), with 470Ω series resistors limiting the LED current to around 6mA. Normally, these LEDs indicate the current motor speed.

The circuit is controlled by potentiometer VR1 and/or infrared remote control via receiver IRD1.

VR1 selects between five different states: full speed reverse, minimum (shunting) speed reverse, stopped (neutral), minimum speed forward and full speed forward. When its position is changed, the loco's speed is ramped. If changing direction, it briefly stops.

Trimpots VR2, VR3 & VR4 allow these speeds to be set. VR2 configures the duty cycle for minimum speed while VR3 selects maximum speed. However when changing from stopped to minimum speed, initially the duty cycle is ramped up until the motor starts to turn. As soon as this occurs, the duty cycle is then reduced to a percentage as set by VR4 and then slowly changes to that set for minimum speed. So VR4 is set to prevent too much of an initial lurch while still allowing reliable starting.

Power is from a 15-18V DC supply which should be capable of at least 1A. Diode D1 (3A) provides supply reverse polarity protection while two 2200µF capacitors provide bulk bypassing for the motor. IC2 also has two smaller bypass capacitors for its own supply.

5V for the micro is provided by a 78L05 linear regulator which is isolated from the motor supply by diode D2 and has further input bypass and output filter capacitors. The supply for IRD1 is filtered by an RC low-pass filter (47Ω/47µF) to remove any switching noise as it contains a high-gain amplifier which can be sensitive to supply noise.

Because the L6203 is being run well below its current rating, it doesn't need a large heatsink and should stay cool.

For remote control, a Sony TV protocol is used. The volume up and down buttons select the direction while the channel up/down buttons switch the speed. Mute is equivalent to moving the control knob to the neutral position. When a valid command is received, the piezo buzzer chirps. If the remote control is not used, replace IRD1 with a 10kΩ pull-up resistor to 5V on pin 4 of IC1.

The software (*train controller.bas*) and user notes are available for download from the SILICON CHIP website. Finally, the L6203 bridge IC can be purchased from Element14 (**au.element14.com**) or Futurlec (**www.futurlec.com.au**). It is also available from DigiKey and Mouser.

Allan Doust, Erskine, WA.

PICAXE plant watering timer

Some plants need a specific amount of water each day, particularly while they are being established; too much or too little and they will not thrive. In this case, it was found that sprayers delivered too much water while drippers tended to get clogged by sand.

The solution was to operate sprayers with a reduced duty cycle compared to the water for the rest of the garden. This unit energises an auxiliary solenoid-driven reticulation valve to spray water on the plants for a fixed proportion of the time that the main solenoid valve is energised, delivering the correct amount of water. That proportion can be set in 15 steps (from 1/16 to 16/16, ie, 100%) and the unit automatically determines how long the main solenoid is energised in order to open the auxiliary valve for the correct period.

The circuit is based around IC1, a PICAXE-08M microcontroller. This drives relay RLY1 using NPN transistor Q1. The timer proportion is set with a combination of four DIP switches (S1-S4). These are numbered 1, 2, 4 and 8 and the timer proportion is calculated as the sum of these numbers, for each switch that is on, divided by 16. Each switch has an associated 10kΩ pull-down resistor to ensure the PICAXE input pins (3-6) are held either low or high.

By setting the watering time for these plants as a proportion of the time the main valve is open, if the weather changes (eg, gets hotter and so more water is required) you only have to alter the timing for the main valve and the auxiliary valve(s) automatically adjust to suit.

The power supply for the circuit is derived from the 24V AC used to drive the main solenoid valve. This is rectified by a DL104 bridge rectifier and inductive spikes (when other solenoids open) are clamped by ZD1, a 62V transient voltage suppressor. The rectified voltage is then filtered using a 100µF capacitor to form a 30-35V DC rail which is then regulated to 5V for the micro using an LM317 adjustable regulator (which handles higher input voltages than a typical fixed regulator).

LED1 (green) lights while ever the circuit has power while LED2 (yellow) lights when the auxiliary solenoid is energised. This is driven from IC1's pin 7 output, in parallel with Q1.

The relay which switches 24V AC for the auxiliary solenoid has a 12V DC coil. Since the rectified supply is much higher than this,

continued on page 72

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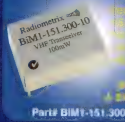

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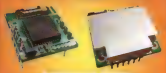

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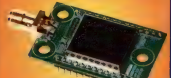

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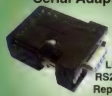

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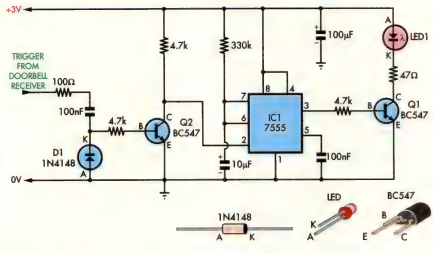

Remote control uses recycled wireless doorbell

This circuit can be used to adapt a wireless doorbell as a remote control to turn on a LED for a short period. It could also be used to control other loads in a similar manner. It was originally designed to be used in sports training, as a way for the trainees to receive a synchronised signal at a distance.

The audio output from the battery-powered doorbell receiver is connected to a 100Ω series resistor and then AC-coupled using a 100nF capacitor and 4.7kΩ resistor to the base of NPN transistor Q2. Diode D1 clamps negative excursions of the signal to about 0.6V below ground to prevent damage to the transistor. Q2 is configured as a common-emitter amplifier with a 4.7kΩ collector load.

As a result, an AC signal from the doorbell (ie, when it is ringing) is effectively rectified by D1 and so turns on Q2, pulling its collector low. This is connected to the trigger input (pin 2) of CMOS 7555 timer IC1. Pulling this input below $^1/_3V_{CC}$ (about 1V) triggers the timer, which is configured in monostable mode. Its pin 3 output goes high for a set period, turning on NPN transistor Q1 and lighting the LED. The 47Ω series resistor sets the current through LED1 to about 20mA, dropping as the supply voltage decreases when the battery goes flat.

The time to light the LED is determined by the 330kΩ resistor and 10µF capacitor connected to pins 7 & 6 of IC1, the discharge and threshold terminals respectively. While the output is low (ie, the LED is off), the discharge terminal keeps the capacitor discharged. When the output goes high, it can charge through the 330kΩ resistor and once its voltage reaches $^2/_3V_{CC}$ (about 2V), the LED goes off and the capacitor is discharged again.

As a result, the LED on-time is calculated as 1.1 x R x C which in this case equals 3.63 seconds. The LED on-time is most easily changed by varying the capacitor value. When the LED is off, the supply current is about 70µA plus what the doorbell receiver draws, so the battery should last for a while.

Kevin Ng,
Normanhurst, NSW. ($40)

Watering timer – ctd from p70

a series 220Ω 5W resistor in conjunction with the 15V 3W zener diode drops the DC voltage to an acceptable level while a 1000µF capacitor across the 15V supply removes the 100Hz ripple. D2 clamps the inductive spike from the relay coil when it is switched off.

If a 5V DC coil relay had been used instead, it could have been powered from REG1's output but the circuit would then draw a lot more current and REG1 would need a substantial heatsink as it could dissipate more than 4W.

There is also an ICSP (in-circuit serial programming) header to allow IC1 to be programmed. The software uses the PICAXE's internal non-volatile memory to keep track of how long the main solenoid is energised. While this NVRAM is specified for a finite number of rewrite cycles, calculations show it should not wear out for at least 42 years in this application.

The software (*Retic Valve Timer.bas*) is available for download from the SILICON CHIP website.

Richard Stallard,
Nedlands, WA. ($60)

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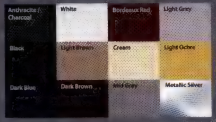

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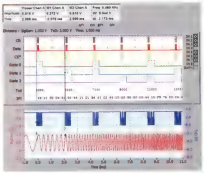

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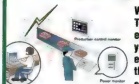

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How to do your own LOUDSPEAKER MEASUREMENTS

By ALLAN LINTON-SMITH

Measuring loudspeakers used to require a lot of expensive equipment, an anechoic chamber and a lot of skill. Nowadays we can do it easily with some low-cost software for the PC, an equally low-cost amplifier to drive the loudspeaker and a calibrated microphone which you can buy cheaply (or you can even make a your own to save even more money).

Accurate, commercial speaker measurement systems can cost tens of thousands of dollars – way outside the budget of even the most dedicated audio enthusiast.

Now, with the advent of well developed PC "virtual instruments" and much-improved electret microphones, we are able to present an economic speaker measurement system capable of accurate and reliable results.

We have often seen enthusiastic loudspeaker experimenters take great care in selecting speaker drivers and mounting them in well-designed cabinets, only to find that the results don't live up to their listening expectations.

More often than not, they can be let down by incorrectly designed crossover systems which cause large peaks (or worse still, deep troughs) or incorrect level adjustments for tweeters and midrange drivers.

This project removes the subjective errors which may result from adjustments made by using only listening tests. The operator will also have a facility to print all response curves.

The test set-up

An audio sweep signal from 20Hz to 20kHz from the virtual instrument is amplified and fed through the speaker under test (SUT).

A wide-range electret microphone set very close to the speaker picks

up the swept signal and its output is amplified and fed to a "virtual" spectrum analyser which then plots the amplitude of the speaker response on the vertical (Y) scale versus frequency on the horizontal (X) scale using a principal known as Fast Fourier Transform (FFT).

The result is a plot of the frequency response of the SUT. In this case we are using a "virtual spectrum analyser" which you can purchase and download from **www.fatpig-dog.com**

The Author describes his Audio Spectrum Analyzer as suitable for "the Acoustic Specialist, Vibration Analyst, RF Engineer or True Geek"!

Even if you're none of those, you'll find the Audio Spectrum Analyzer easy to use and a very worthwhile program to own.

Best of all, at just $US39.99 the software is very reasonably priced but with the volatile Aussie dollar at the moment we won't even hazard a guess at the $AU price; we imagine it will be fairly close to the $US price.

It also has a built in "tracking generator" (TG), which sweeps across the desired frequency range, in step with the analyser.

The audio sweep signal is fed to a "Champ" amplifier (SILICON CHIP, February 1994). This "oldie but a goodie" has been modified to give a flat frequency response and can drive an 8-ohm speaker to about half a watt.

This may not seem very much but you will be surprised how loud it can be and it is certainly adequate for frequency response testing. Of course, you could use any power amplifier which has as good or better response than the modified "Champ" which is ±0.2dB from 20Hz to 20kHz

The signal from the loudspeaker under test is picked up by a specially built microphone or a commercial calibrated microphone. We'll have more details on these later in this article.

The electret then feeds our "Pre-Champ" preamplifier (SILICON CHIP, July 1994) which has also been modified for a flat response. The resultant signal is fed to the spectrum analyser for processing. You can save and print your response curves for further analysis. Both the "Pre-champ" and "Champ" are mounted in the same die-cast box but each has a separate battery

The finished test unit comprises modified "Pre-Champ" and "Champ" units with components chosen to give a flat frequency response. The output from the preamp can be taken from either the 3.5mm mono jack or from the RCA socket. The hardware at the bottom of pic is a bathroom towel rail holder, used to hold the test unit on its stand as seen in the pic on the opposite page.

Specifications:

Microphone frequency response:	(31.5Hz-20kHz) ±2dB
	(31.5Hz-16kHz) ±1dB
	(20Hz-20kHz) ±2.5dB
Preamplifier frequency response:	±0.2dB (20Hz-20kHz)
Power amplifier frequency response:	±0.2dB (20Hz-20kHz)
Power amplifier output (before clipping):	200mW into 8 ohms
Frequency response of virtual instrument:	±0.4dB (20Hz-20kHz)
Overall measuring accuracy: (*without calibration chart*)	±2.9dB (20Hz-20kHz)
Overall measuring accuracy: (*using calibration table*)	±1dB (20Hz-20kHz)
THD+N preamplifier:	0.1% at 1kHz (22Hz-22kHz).
THD+N power amplifier:	0.4% at 1kHz (22Hz-22kHz) 250mW
Crosstalk from pre-amp:	-63dB at 1kHz, 20mV input
Crosstalk from poweramp:	-47dB at 1kHz, 20mv input
Preamp input maximum:	50mV
Preamp input minimum:	10mV
Power amp input maximum:	500mV
Power amp input minimum:	30mV
Preamp phase distortion:	±6.35° (below 200Hz).
Preamp intermodulation distortion:	0.1% (88mV output 70Hz/7kHz).
Preamp signal-to-noise ratio:	-107dBV (10Hz-80kHz ref 630Hz 25mV)
THD+N tracking generator: (*using Acer Aspire One model KAV10 with Windows XP*)	0.0066% at 1kHz (22Hz-22kHz)

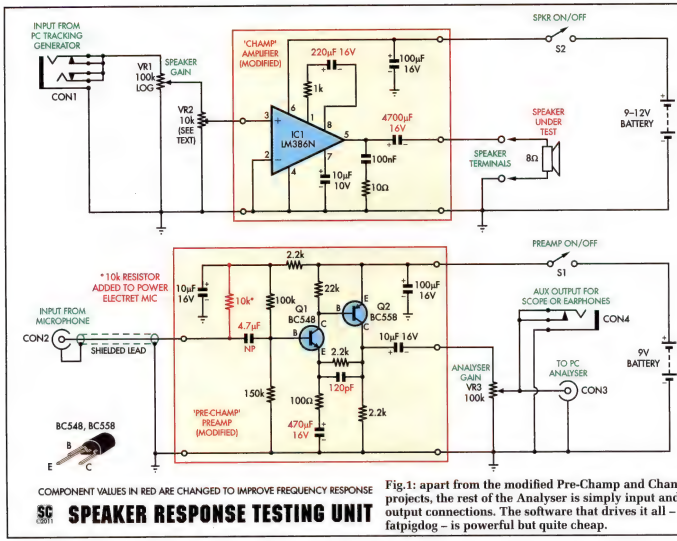


Fig.1: apart from the modified Pre-Champ and Champ projects, the rest of the Analyser is simply input and output connections. The software that drives it all – fatpigdog – is powerful but quite cheap.

to minimise crosstalk and feedback.

Not only is the setup useful for measuring loudspeaker frequency response, it can also be used to plot the frequency response of an amplifier, pre-amplifier, audio filter or crossover network.

It is also handy as a general purpose portable microphone for public address systems or DJ work or even for good quality recording – just plug it into any line input or power amplifier.

Also, if you plug it into a frequency counter, you will be able to accurately tune instruments (assuming you know or find out what frequency equates to the notes in your particular instrument).

The virtual spectrum analyser will also be very useful as a training tool because it has been specifically designed to look and feel like a typical bench top analyser.

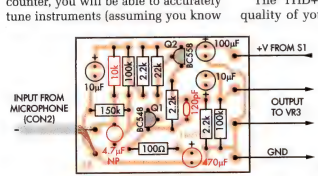
The new tracking audio generator included in the fatpigdog software is very useful too. It measured 0.0066% THD+N (at 1kHz when set at 635mV on "zero span"; measured on an Audio Precision test set!).

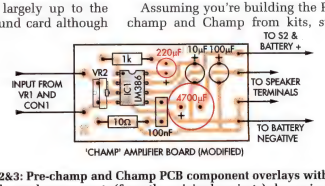
The THD+N is largely up to the quality of your sound card although ours was measured from the standard sound card in an Acer Aspire One which cost less than $500.

You can also use it all as a spectrum analyser and waterfall analyser and play around with various colour modes. It requires some skill and patience (just like a real benchtop spectrum analyser) but if you experiment, you will learn to master it all fairly quickly.

Construction

Assuming you're building the Pre-champ and Champ from kits, start





Figs.2&3: Pre-champ and Champ PCB component overlays with the changed components (from the original projects) shown in red.

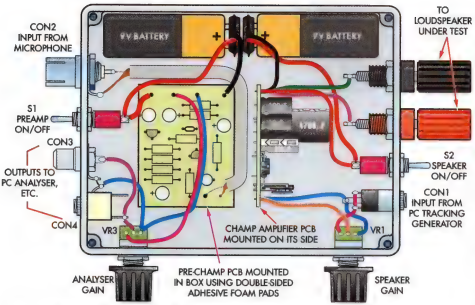


Fig.4: use this assembly diagram in conjunction with the photo below when you put it all together. The two PCBs are secured to the case with double-sided foam adhesive pads (the Champ must go side-on). Two separate batteries are used to minimise interaction between the sections.

by constructing the Pre-champ pre-amplifier as per the instructions given (or refer to the article in SILICON CHIP, July 1994).

Note that you need to change the values of three capacitors, as shown in Figs.1 & 2. These should easily fit on the PCB.

If all goes well, you can then start on the "Champ" power amplifier as per the kit instructions (or SILICON CHIP February 1994).

Again, there are slight modifications required. Figs.1 & 3 show these, which involve changing two capacitors. The 4,700µF capacitor does fit on the PCB but it is a bit too tall and the finished amplifier will have to be mounted on its side so it can easily fit in the diecast box.

Once the two PCBs are completed, you can drill and mount all the hardware on/in the diecast box using Fig.4 and the photos as a guide.

Solder all the connecting wires according to the diagram. It will be easier to solder the wires to the boards first then solder the wires to all the switches and sockets before mounting them inside the box.

Because the circuit boards are tiny and have no provision for normal screw mounts, you will have to use some good quality, thick, double sided foam pads.

Cut the pads to cover the bottom of the "pre-champ" board then press it firmly in place, allowing plenty of room for everything to clear.

The 100kΩ log pot is mounted directly to the diecast box for convenience but the original 10kΩ pot is retained on the PCB as a "preset" to take care of variations between sound card outputs. Later we'll set the maximum output of the Champ to prevent clipping and excessive distortion.

This is the EMM-6 calibrated microphone from Dayton Audio, which sells for about $80. Or you can make your own (as described in the text) for a whole lot less!

The microphone

If you wish, you can make your own microphone to use with this system – details follow.

Or you can buy a ready-made calibrated microphone – for example, the EMM-6 Measurement Microphone from Dayton Audio (a company in Springboro, Ohio, USA) sells for about $US80. It's a precision electret condenser microphone designed for measurement and critical recording applications. However, this microphone requires a minimum 15V phantom power so you'll need to arrange a separate phantom supply (two 9V batteries in series would be fine).

Once you've purchased this mic you can then download its own calibration data text file.

Further information (including a

Everything fits neatly into the small diecast box. Note the two independent 9V batteries. Don't forget to turn on both switches before making measurements! The bathroom hardware at the bottom of the pic is a cheap way to hold the unit in place!

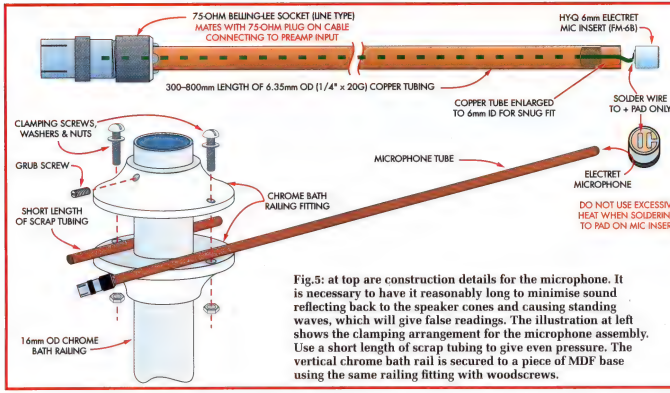


Fig.5: at top are construction details for the microphone. It is necessary to have it reasonably long to minimise sound reflecting back to the speaker cones and causing standing waves, which will give false readings. The illustration at left shows the clamping arrangement for the microphone assembly. Use a short length of scrap tubing to give even pressure. The vertical chrome bath rail is secured to a piece of MDF base using the same railing fitting with woodscrews.

spec sheet) is available from www.daytonaudio.com/index.php/emm-6-electret-measurement-microphone.html

Making your own

You'll need a length of 6.35mm (1/4in) copper pipe, at least 300mm or so long.

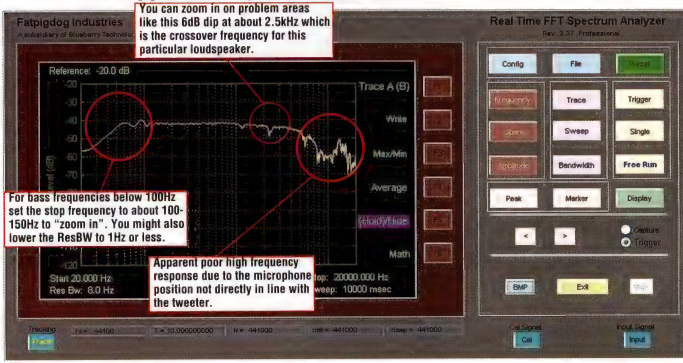
As the ID of 6.35mm pipe is about 4.85mm and the electret microphone OD is 6mm, you'll need to enlarge the end of the pipe to accommodate same, down to a depth of about 6mm.

Drilling the pipe out is possible but impractical due to the thin copper wall – it's much better to force a punch or something similar into the end to expand the soft copper slightly.

A pipe flaring tool might also be useful here but we haven't tried it.

Once done (check the electret fits but don't get it caught in the tube!), you need to solder a connection to it.

Using a clean, hot soldering iron, solder a single wire to the positive terminal of the electret – be careful because too much heat will damage



The virtual analyser showing the frequency response of a three-way loudspeaker. You can adjust the start and stop frequencies to 20Hz-200Hz and resolution to 1Hz to improve the bass response curve. Note the tracking generator "button" at the bottom left. Insets are some things you could look out for when fine-tuning speakers.

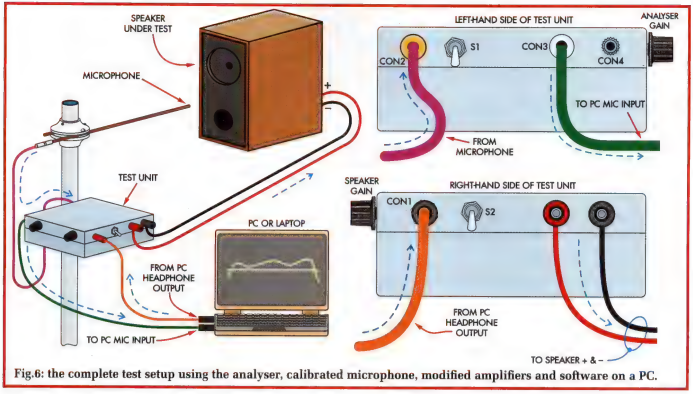


Fig.6: the complete test setup using the analyser, calibrated microphone, modified amplifiers and software on a PC.

the low-end response of the electret.

A gas powered soldering iron wound up fairly high is ideal.

(It is a good idea to buy two or three electrets in case an accident happens – they are quite cheap).

Then, run the wire down the centre of the copper tubing and mount a 75Ω female co-ax plug to the other end. The one we used required no solder and the wire was simply screwed into the centre then pushed back in.

The copper tubing then acts as the "ground" connector at both ends and also forms a good shield.

Cut a length of coaxial cable to about 1-2 metres long and fit a male co-ax plug to each end.

Once you have completed the microphone assembly, it is important to have a good solid stand so you can accurately position the microphone in front of the speaker under test.

We used 16mm bath rail fittings that you can buy from any hardware store.

We mounted a length to a piece of board, then clamped the copper tubing with two of the 16mm round ends using small nuts and bolts.

A "thru" chrome rail fitting was bolted to the diecast box and the opening was drilled and tapped to fit a clamping screw.

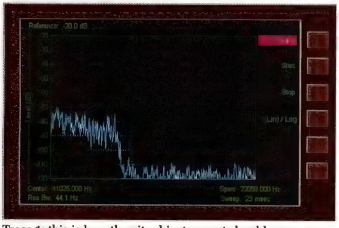
The alternative is to secure the unit by merely using insulation tape wound neatly around the vertical support to stop it from slipping down.

Checking it out

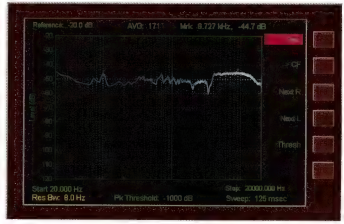
Now all you need to do is plug all the wires in as per Fig.6 and switch everything on.

Check to see if the microphone is working by talking or whistling and measure the output with a DMM set on AC (or plug the output into an amplifier or oscilloscope). The latter is best because you will see immediately if you are getting a clean sine wave.

Alternatively, you might like to plug the output of the Pre-champ into the



Trace 1: this is how the vitual instrument should appear after startup in the factory-preset mode. It displays a resolution bandwidth of 44.1Hz, a sweep time of 23ms and a span of 22.05kHz (see Spyro's comments on how to set it up).



Trace 2: this looks like excessive bass but this is because the analyser and soundcard response is too slow with 125 milliseconds so we need to zoom in to the lower frequency range.

mic socket of your computer soundcard and view your "whistle" on the spectrum analyser.

Your whistle should give you a peak at around 1-2kHz plus harmonics at 2 and 3kHz.

Once all your checks are done (and hopefully everything works!) you will finally be ready to fine-tune it all and try some frequency response testing.

The test setup

We assume that you have downloaded the software from www.fatpigdog.com/SpectrumAnalyzer

The originator, Spyro Gumas, is very communicative and can assist if you have any problems.

We used Windows XP but the website lists alternatives for those using Vista, Windows 7 etc.

Run the program and you will first see the black-and-white MS-DOS screen appear.

You may have to wait (perhaps two minutes or so) and the instrument will appear similar to the screen grab opposite.

Once the virtual instrument pops up, this is how to set it up for frequency response measurements, making sure that the inputs and outputs to the test unit and computer are correct (see Fig.6).

Switch the test unit on and adjust the microphone so it is approx 40-100mm away, in a direct line, from the tweeter or speaker unit under test.

Connect the computer's headphone jack output to the input of the "Champ" power amplifier and attach the Champ output to the speaker under test (SUT).

(We converted the stereo output signal from the soundcard to mono at the input socket but one channel is OK).

On the virtual analyser:

Click on "preset" to clear any previous settings.

Click on frequency

Click on start (F2) and type in "20" <enter>

Click on stop key (F3) and type "20,000" <enter>

(The range is then 20Hz-20kHz)

Click on Lin/Log key (F4) so you see lin/(log).

The frequency range is set to a logarithmic scale 20Hz-20kHz.

Then:

Click on bandwidth

Click on RBW and type in "8" <enter>

Click on sweep, then click time (F2) and type "10000" <enter>

Click on "trace" and then "average"

The analyser will then sweep continuously and indicate the number of averages at the top of the page.

The analyser is now ready to do a 10-second sweep of your loudspeaker from 20Hz to 20kHz with a resolution of 8Hz and will average the response curve (5-50 averages will probably be sufficient).

Click on "track" and you should hear the signal sweep from 20Hz to 20kHz; this repeats every 10 seconds. You can adjust the volume of your loudspeaker as it sweeps and save an image anytime by pressing "BMP" (bitmap).

You may find that the low-frequency part of the trace jumps around. This is normal because the sweep is not slow enough (10 seconds is maximum) to allow the analyser to capture it properly (see traces 2 & 3 for examples).

To fix this, try starting the sweep at 20Hz and stopping it at 200Hz or even 100Hz, and play around with the RBW (resolution bandwidth), which you can set as low as 0.1Hz!

Refer to the manual (downloaded) if you have difficulty because some computers have different delay arrangements with the soundcard and you may need to compensate the analyser with Tstupid.

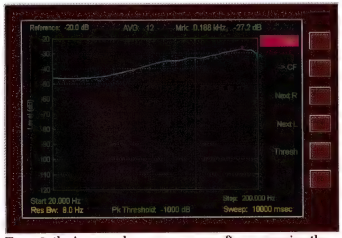
What is Tstupid? It's a part of the fatpigdog software. When data capture is initiated with the audio capture card in My PC, the initial gain response is zero, or pretty close to it. My audio card takes approximately 100ms for its recording gain to stabilise. Tstupid is an advance in the amount of time that the spectrum analyser captures data for a Single sweep or for the first sweep of a Free Run. The captured data during the Tstupid interval is discarded. The user has access to this parameter to use at his peril. The default value is 100.

You can also adjust the volume of the speaker and the gain from the microphone until you get a nice-looking trace.

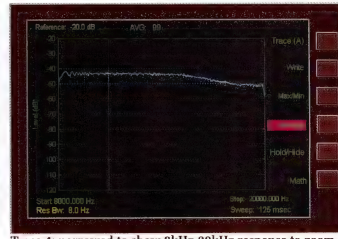
If you wish, you can make adjustments to your speaker while the analyser is sweeping; such as tweeter or midrange volume levels (if an L-pad is fitted) or by moving the microphone into different positions away from the tweeter.

When you are happy with a particular trace, you might like to activate the marker to examine a point of interest.

Click on "marker" then "ON" and you will see a red dot



Trace 3: the improved response curve after narrowing the frequency range to 20-200Hz and keeping the 10s sweep time for 12 averages. You can reduce the Res Bw to 0.1Hz, but the analyser will take a longer time to do a trace.



Trace 4: narrowed to show 8kHz-20kHz response to zoom in on the tweeter. This speaker is very smooth but drops away 5dB or so at the higher frequencies. The dip at 20kHz is due to the microphone response being 2.75dB lower.

Rockby Electronics

SOLARKING Monocrystalline Solar Panels

Monocrystalline solar panels are designed for long life (up to 20 years) and high efficiency output. These units may be ganged into arrays for applications where high power output is required eg for large battery banks. An excellent solution for remote or mobile power applications, electric fence battery banks, inverter systems, RV's, caravans, boats etc.

Stock#:	Max Power	Rated Voltage	Short Cct Curr.	Open Cct.	Dimensions LxWxH	Price
#36994	**10W**	12.0V	**0.56A**	22.0V	396 x 289 x 23	**$29.95**
#36995	**20W**	12.0V	**1.17A**	21.6V	645 x 295 x 25	**$59.50**
#36996	**40W**	12.0V	**2.28A**	21V	645 x 545 x 23	**$134.50**
#36997	**80W**	12.0V	**4.55A**	21.8V	1210 x 540 x 35	**$220.50**
#37873	**120W**	12.0V	**6.82A**	21.8V	1500 x 660 x 35	**$394.40**

Features:
*Heavy Duty Aluminium Frame
*20 Year Limited Warranty
*Monocrystalline Silicone
*3mm Tampered Glass

36V 185W Monocrystalline Solar Panel

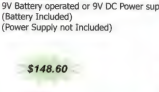
Specifications:
Max power: 185W
Open circuit Voltage: 45.01V
Short Circuit Current (Isc): 5.55A
Max Volt (Vmp): 36V
Max Current(Imp) : 5.14A
Dimensions: 1580 x 808 x 35mm
Weight: 14.4kg
Manufacturer: Solar King

Includes:
*Short power cable
*Junction box

$319.00
#38653

12VDC Solar Battery Trickle Charger

Lead acid cells will self-discharge, even when completely disconnected, if they are not re-charged regularly eg when a car is not driven for long periods or on a boat which is used infrequently. Includes suction cups for mounting to inside car windows, alligator clips and cigarette lighter adaptor lead.



$12.00
#36450

Solar Charger Regulator

Specifications:
Battery Voltage:12V
Open circuit Voltage:12V
Continous charge:20A
Maximum charge current:25A
Maximum load current:25A
Operation Current:30mA
Voltage across terminals (PV to Battery):0.8V
Voltage across terminals (Battery to Load):0.4V
Recommended wire size:#12 AWG
Dimension (WxHxD): 150 x 85 x 45mm
Operating Ambient Temperature:-10 to 50°C

#36998	**20A**	12V	$85.50
#38179	**30A**	12V	$115.50
#38238	**20A**	24V	$119.30

$148.60
#36578

Led Indication PC Cable Tester

Tests: D type 9,15,25 HD15,36W Centronics,BNC, RJ45,USB A,USB B, FIREWIRE 1394.
9V Battery operated or 9V DC Power supply (Battery Included)
(Power Supply not Included)

20A 1-30V Lab Power Supply

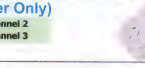
A 1-30V, 20A adjustable current limiting power supply. Both voltage and current settings may be set in fine or coarse modes allowing precise adjustments. Includes three programmable preset outputs. Remote control of settings is also possible. Fixed 5A auxiliary output on the front panel allows quick connection to devices. When initially powered up the unit performs self diagnostics to ensure reliable operation.

Specifications:
Voltage output: 1 to 30V DC @ 20A
Auxiliary outputs: 1 to 30V DC @ 5A max
Output current: 20A max
Ripple & noise: Less than 5mV
Load regulation: 50mV 0-100% Load
Appx. Size(WxHxD): 200 x 90 x 215 mm
Net weight: 2.6kg

$318.00
#39661

USB Mini Inspection Camera (520mm Neck)

The camera is only 10mm diameter and has two variable intensity LEDs for illuminating the area under examination.
* Mirror and magnet pick-up tool included
* Flex Camera Neck:10(Dia) x 520(L)mm
* Cable Length: 1.5m



$28.80
#39156

Wireless Mains Power Monitor

Monitor the running costs of up to three electrical appliances with this mains power meter. Consists of a master base station which receives RF signals from up to three remote mains socket senders. The senders simplyplug inline between your appliance and the standard GPO. Includes base station and one GPO transmitter, 2 additional transmitters may be added if required. Requires 3 x AA batteries.

Features:
* Monitor energy usage of up to 3 appliances at once
* RF wireless up to 30m
* Displays energy usage in kW/h or currency
* Clock with alarm function

#38820

$35.60

Wireless Mains Power Monitor (Transmitter Only)

#38821	**Channel 2**
#38822	**Channel 3**

$21.50

LED Flood Lights (Cool White)

Wavelength: 6000 - 7000K
Manufacturer:Shenzhen Getian

Stock#	Power	Volt.	Curr.(approx)	Luminous	Size (mm)	Price ea
39322	**10W**	12VDC	0.9A	600-700	114(W) x 86(H) x 83(D)	**$68.53**
39452	**20W**	12VDC	2A	1200-1400	225(W) x 186(H) x 135(D)	**$149.60**
39325	**40W**	24VDC	1.8A	1800-2100	285(W) x 235(H) x 165(D)	**$197.56**
39460	**50W**	24VDC	2.3A	3000-3500	285(W) x 235(H) x 150(D)	**$209.00**

12V 5A 60W Switchmode Power Supply

$21.50

DC Voltage: 12V
Rated Current: 5A
Rated Power: 60W
Ripple and Noise: 100mVp-p
Voltage Range: 90-264VAC
Manuf.: Meanwell

#38911

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Ph: (03) 9562-8559 Fax: (03) 9562-8772
ABN# 3991 7350 807 ACN# 006 829 821

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Victoria 3166

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Stock is subject to prior sale

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Web Address: www.rockby.com.au
Email: salesdept@rockby.com.au

For on-line Ordering and other Products see our web site www.rockby.com.au

appear on the trace

Then move the marker to the area you want to measure by clicking on "<" (backward) or ">" (forward) keys.

The marker reading appears at the top of the page eg, "Mrk 2.558kHz, -86.2dB"

Correcting the microphone

Once you have measurements of the points you are interested in, go to the correction table below (Table 1) and add or subtract the dB value at the frequency of interest.

For example if you measured -26.5dB at 20Hz you have to **add** 3.7dB to get the corrected value because the microphone's own response falls off at low frequencies (see trace 5).

We aimed for an accuracy of ±1.5dB but by using the correction table we have achieved better than ±1dB.

The measurement is dB relative to the reference signal. It is NOT a dB sound pressure level (dB SPL) measurement.

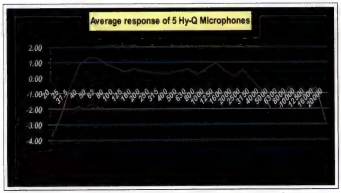
We cannot give you a reference because every soundcard will have a different internal gain.

To change to dB SPL you will need to calibrate your test setup against a known sound pressure level by using an accurate sound level meter or by using a "microphone calibrator" which emits a pre-determined audio output at point blank range

You may also use a speaker which has a specification for SPL, eg, 90dB SPL at 1W 1m at 1kHz – but of course you

Frequency (Hz)	ADD dB to measurement
20	3.70
25	2.35
31.5	0.45
40	-0.89
50	-1.35
63	-1.29
80	-0.88
100	-0.68
125	-0.44
160	-0.60
200	-0.46
250	-0.33
315	-0.28
400	-0.31
500	-0.47
630	-0.59
800	-0.23
1000	-0.59
1250	-0.96
1600	-0.47
2000	-0.08
2500	-0.48
3150	0.16
4000	0.78
5000	2.02
6300	2.02
8000	0.57
10000	1.33
12500	0.99
16000	0.64
20000	2.75

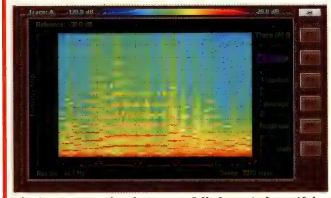
Table 1: correction table for HY-Q FM 6B electret microphone.



Trace 5: we took five Hy-Q FM-6B electret microphones and averaged their responses at a range of frequencies to produce the curve above. The same figures are reproduced in table form above. Using these figures you can correct for variations in the microphone response. For example add 3.7dB to your reading for 20Hz and 2.35dB to the 25Hz reading and so on. Accuracy after correction will be ±1.0dB.

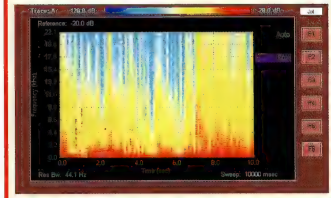
Other Applications

The software will also enable you to do waterfall analysis. This is really a way of viewing a spectrum analysis as it varies over time. It can be used for making "voice prints" or charts of audio signals.



The instrument also does waterfall charts in beautiful colours with frequency (horizontal axis) vs time (vertical axis). Colour code is at top and represents the intensity of the signal.

The screen grab above shows the waterfall chart for 2.270 seconds of the Bruch Concerto No 3 for violin and shows the rich harmonics. The vertical scale shows the frequencies of the various harmonics while the horizontal scale is time so the whole chart is a record of a few notes of music.



A waterfall of Shakira singing "How do you do". Interpretation of these charts is strictly up to your imagination!

To set up for Waterfall Charts

The wiring setup is virtually the same as for testing loudspeakers except that music or voice has to be fed to the loudspeaker from a CD player or MP3 player, or from the microphone "Prechamp" output (for voice prints)

The setup for the virtual instrument is:

Click on "preset"

Then "display"

Then "waterfall F2"

Then "rotate"

Then try different sweep times and resolution bandwidths (Res. Bw…).

And try different colour schemes by clicking on "jet"

Press BMP to save the image you want.

siliconchip.com.au

will need to push the champ to 1/2 watt (ie, 2V RMS for an 8Ω speaker) at 1kHz by

clicking on "frequency"
then "centre frequency'
then "1,000 enter"
then "span"
then "zero F3"
then "track"

This will now set the generator at 1kHz and you can feed this to your speaker (you will hear a clicking sound on each sweep so set the sweep time to 10,000mS).

The real SPL at 1m will then be close to an SPL of 84dB (1/2 the specified value) or 90dB at 0.5m (because watts=V^2R and sound level is an inverse square function).

That is only true if the manufacturer's specification is correct, so you might try different speakers – or just don't worry about it if you don't really need it!

Preventing clipping and distortion

You can set the maximum output from the "Champ" by setting the preset at a value which prevents clipping and excessive distortion.

You can do this by setting the spectrum analyser centre frequency to 100Hz and then "zero span".

The maximum output to the speakers can then be measured with an AC voltmeter (make sure you fit an 8Ω, 0.5W resistor as a dummy load) and the preset adjusted so the output does not exceed 1.5V RMS and that you have fully advanced the 100kΩ pot. Once this is done, you can be certain that you will not accidentally clip and distort the signal going to the speaker. SC

Parts list – Speaker Testing

1 Diecast case, 119 x 94 x 34mm (eg Jaycar HB5067)
1 "Champ" amplifier kit (Silicon Chip, February 1994)
1 "Prechamp" preamplifier kit (Silicon Chip, July 1994)
1 6mm electret microphone insert (Hy-Q Electronics FM-6B)
2 SPST switches (panel mounting, any type)
1 75Ω panel socket
1 75Ω male plug
1 75Ω line socket
1 banana socket (black)
1 banana socket (red)
1 RCA socket
1 3.5mm stereo socket
1 3.5mm mono socket
1 length coax cable (~1m)
2 knobs (colours to suit)

Note: nominated parts were those used in the prototype but you can use plugs/sockets etc you may have on hand.

Capacitors (changes to components supplied in kits)
1 4700μF 16V electrolytic
1 470μF 16V electrolytic
1 4.7μF 16V electrolytic (non polarised preferred)

Potentiometers
2 100kΩ miniature panel mount type

Software
Fatpigdog Virtual Analyzer (see text)

Hardware
1 length 6.5mm x 20G annealed copper pipe (~500mm)
16mm chrome bathroom fittings as required

A word from Spyro Gumas, originator of the Fatpigdog Spectrum Analyser

The inspiration for the name "Fatpigdog" is our pug Buddy, a truly Fat Pig Dog. The inspiration for the software itself was my frustration in trying to use virtual spectrum analysers with their non-intuitive user interfaces. Having used spectrum analysers quite a bit, I yearned for a virtual tool that worked the same way the real hardware tools work. I can't say I've totally achieved this objective but I do think that anyone with experience using an HP, Agilent or Tektronix analyser will find my software so easy to use that they can throw away the Users Manual.

The spectrum analyzer starts up in a factory preset mode, displaying the full frequency (SPAN), with an update time (SWEEP) of 23ms and a Frequency Resolution (BANDWIDTH) of 44.1Hz. This will get you started, but lets say that you decide to drill a little deeper. You're playing with Ye Olde Fatpigdog Spectrum Analyser (that's how we all talk up here in the states) while watching your favorite television program on your old fashioned (tube) TV.

You notice a strong signal peak centered at 15.734kHz (NTSC system, 15.625kHz for most of you other folks) and wonder if that could be the arcane horizontal sync frequency emanating from the sync oscillator.

So, you click FREQUENCY, type in 15734 (humor me) for the center frequency and hit Enter. So far so good, the display has shifted, but now you want to adjust the span so you can zoom in on any possible spectral structure. So, you click SPAN, type in 100, and click Enter.

Whoa, everything comes to a crashing halt. The display is now updating once every 5 seconds. Why?

So here's the secret. With SWEEP and BANDWIDTH in the default AUTO modes, the spectrum analyser is going to automatically set bandwidth equal to SPAN/500 [This ratio is a magic number that you can change under the CONFIG menu, labeled Span/RBW.] Now here's the science behind Resolution Bandwidth (RBW): to get frequency detail at a resolution of RBW Hz, you need to analyse a length of audio signal that is 1/RBW seconds long. So when we set our SPAN to 100Hz, the spectrum analyser automatically set RBW to 0.2Hz (100Hz/500) and then computed a corresponding SWEEP time of 5 seconds (1/0.2Hz). Aha.

So what can you do about this? ... A Lot! Don't let the software push you around. You've been given full flexibility, courtesy of the wizards at Fatpigdog Industries. You can change the magic number Span/RBW to something like 50 and voila, the SWEEP goes to 500ms. But this is kind of gross, to be truthful since the frequency resolution is very coarse now. So, let's set Span/RBW back to 500. Now click SWEEP, and then the TIME soft key. Enter 50. Now the Sweep is updating every 50ms, but the bandwidth is still very fine (RBW still is 0.2Hz).

But it looks strange, a certain squirreliness to it. That's because the spectrum analyser is still processing 5s blocks of data to generate the fine frequency resolution but its processing a sliding 5s window of data, every 50ms. This means that every 50ms it is processing 50ms of new data and a residual 4950ms of data from the last update.

Thus you are seeing fast updates, but the spectrum is the result of averaging over 5s. It's a compromise! That's how it works, you trade off speed for frequency resolution but you can get both if you are willing to smear the spectral changes over time.

I like to think of this as the time/frequency Heisenberg Uncertainty Principle ... more on that some other time (but you certainly can Google it!). I hope you enjoy the Spectrum Analyzer.

One-Stop Tech Gift Ideas

Universal Remote, Keyboard & Mouse All-In-One! A 1004

This versatile backlit Sunwave® universal remote features a unique double sided design for use with both hi-fi & computer equipment. It's ideal for the new range of smart TV's and media centres on the market. Quick setup to suit your devices via a comprehensive code library and PC software. It even works with popular game consoles, providing an easy way to text chat with friends. Includes USB dongle.

2.4GHz wireless | IR Learning | Requires 2xAAA batteries.

SAVE 20%
$22
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-40°C range. Ideal for cool rooms

Wireless Desktop Weather Monitor

This compact desk unit measures indoor temperature; outdoor temperature and humidity. -40°C to +65°C. Sensor range 100m. Requires 2 x AA & 2 x AAA batteries.

Wireless 2.4GHz Headphones

Wireless freedom up to 30m from your home hi-fi, laptop or MP3 player. 8 channels for interference free operation. Requires 2xAAA batteries.

Super comfortable with deep bass

NEW $99 C 9031

C 9011

Woodgrain In-Ear Bud Earphones

Excellent audio performance coupled with great wood grain finish. Includes 3 sets of silicon ear cups.

NEW $29.95

BUY 2 PAIRS FOR $40!

Applications:
- Off-road adventurers
- Caravans & camping
- Boats & yachts

INTRODUCTORY SPECIAL!

Includes carry bag.

N 1085 65W — SAVE 554 $495

N 1140 140W — SAVE 594 $855

Backup Solar Power Anywhere, Anytime!

An excellent backup power source for those off-road adventures or whilst at remote camp sites. In-built 3 stage solar regulator ensures the protection for your batteries and keeps them performing at their peak. Fitted with an adjustable stand to ensure you capture maximum solar energy throughout the day. 4m connection lead.

See Inside Walls, Pipes & Conduits...

...with this handheld inspection camera & 2.4" LCD monitor. Great for accessing difficult locations such as wall cavities, ceiling spaces, pipework, industrial machinery & engines. Requires 4xAA batteries for camera. Includes carry case.

Great for mechanics, plumbers and installers

S 8742 NEW $169

Christmas Lighting Kits

Operates with the K 5885 master controller kit (below)

NEW KIT $89.95 K 5887 LED Slave

NEW LED Christmas Light Controller Kit

(SC October '11) This new LED light slave controller kit will operate with the K 5885 master unit (below). Drive up to eight strings of LEDs, each string with completely individual control. Up to four slaves can be used per system - thats 32 channels of lights!

SAVE 20% $55 K 5885 Master

SAVE $30 $169 K 5886 Slave

Christmas Lighting Extravaganza Kits!

(SC October '10) Brings your christmas light show to life! Lights will flash, dim up & down in time with your favourite Christmas carols. Power up to 32 channels of lights from a master unit & 4 slaves. Each slave can run up to 2300W of lighting. Music input via SD card. Includes cases.

Also great for shop displays, promotional events & interactive exhibits.

Latest Hi-Tech Accessories

Bike helmet for illustration purposes

1080p HD Sports Action Camera Pack

High definition recording for skydiving, trekking, mountain biking, rock climbing, mountaineering, skiing, snowboarding, motorcross, car racing and more! • Sensor rotates to keep horizon level • In-built screen • Uses Nokia phone Li-ion batteries (2 included) - rechargeable via USB • Includes various mounting brackets & straps for helmets, bikes etc. • Water resistant.

Includes car power adaptor | 1080p recording | HDMI output

Hands Free Tablet Reading

Benchtop stand for tablet & e-Readers. A must have for web surfing, reading recipes and watching movies. Non-slip rubber feet. Universal design suits most popular tablets and readers. Folding aluminium construction.

iPad® for illustration only.

H 8250

NEW $24.95 GREAT GIFT IDEA!

NEW $68 D 5507

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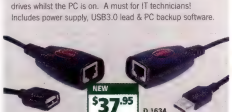

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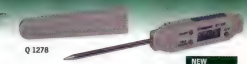

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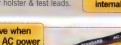

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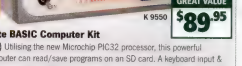


K 9550 GREAT VALUE $89.95

The Maximite BASIC Computer Kit

(SC March '11) Utilising the new Microchip PIC32 processor, this powerful embedded computer can read/save programs on an SD card. A keyboard input & video output is provided, plus 20 digital/analog inputs and outputs. Utilises BASIC programming language allowing a massive scope of applications. • 128K RAM • USB connection • Powerful BASIC interpreter • Requires 9V power supply (M 9237A $17.95) • SD card sold separately (DA0320 4GB $21).

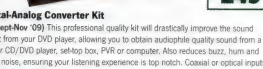
NEW!

K 9552 NEW KIT! $49.95

Mini-Maximite BASIC Embedded Module Kit

(SC November '11) The 'little brother' of the Maximite kit. Utilising identical software it is designed as an intelligent controller for embedding into larger systems. Features 20 I/O pins, 128K RAM, VGA/composite out, USB2.0 & keyboard interfaces. All from one low cost IC!

Audiophile quality stereo sound!

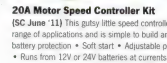


K 5332 SAVE $50 $249

Digital-Analog Converter Kit

(SC Sept-Nov '09) This professional quality kit will drastically improve the sound output from your DVD player, allowing you to obtain audiophile quality sound from a regular CD/DVD player, set-top box, PVR or computer. Also reduces buzz, hum and signal noise, ensuring your listening experience is top notch. Coaxial or optical inputs. RCA output. 240V mains operation.

Top Value



K 6007 NEW KIT! $48.50

20A Motor Speed Controller Kit

(SC June '11) This gutsy little speed controller has a wide range of applications and is simple to build and use. • Low-battery protection • Soft start • Adjustable pulse frequency. • Runs from 12V or 24V batteries at currents of up to 20A.

SAVE 15% $55 K 1677

12VDC Battery Charge Controller Kit

(SC April '08) Works in tandem with a power supply or standard battery charger to provide staged float charging for sealed & non-sealed lead acid batteries.

K 6120 Can be monitored using PC software. SAVE 12% $42

Smart Fan Controller Kit

(SC July '10). This compact module regulates the speed of up to eight 12V fans. Measures up to 4 temperature points & smoothly controls fan speed. Ideal for computers, greenhouses, home breweries, amp cooling etc.

K 5513 SAVE 33% $25 BARGAIN PRICE!

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(SC August '06) Adds a low noise RIAA phono input to any amp and allows easy line level recording. Prevent the deterioration of your vinyl by converting them to MP3. Can be equalised to suit 45's, 78's & LP's. Requires M 9265A 12VDC plug-pack $18.95.

K 5514 SAVE 25% $33

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(SC Sept '10) Mini Mic Pre-Amp Kit. Boosts signal levels for better volume from unpowered mics when used with a mixer or PC sound card. • Suits balanced or unbalanced mics • Low noise & distortion • Line level output. • 5-20VDC input.

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Find out what its REALLY costing you to run your appliances! **(SC July '04)** Simply connects inline with your appliances and provides usage figures in both kilowatt hours (kWh) or dollars. Also protects from brownouts.

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Ultra-LD Mk.3 Stereo Amplifier . . .

Pt.2: By JOHN CLARKE & GREG SWAIN

Low-Noise Stereo Preamp With Motorised Volume Control & Input Selector

In Pt.2 this month, we describe the assembly of the Input Selector module and its companion Switch Board. We also show you how to make the IDC cables that link the modules together and give the remote control set-up and test procedure.

THE 3-INPUT SELECTOR board (Fig.13) is straightforward to assemble. Install the resistors and diodes D1-D3 first, then install the ferrite beads, the IC socket and the MKT capacitors (do not use ceramic capacitors on this board).

Once these parts are in, install the four transistors, noting that Q5-Q7 are BC327s while Q8 is a BC337. The two electrolytics can then go in, followed by the 10-way and 14-way header sockets. **The header sockets must be installed with their slotted key-ways towards the top.**

Finally, complete the assembly by installing the relays, the three stereo RCA input sockets and the two vertical RCA output sockets. Note the left and right labelling for the output sockets – this is not a mistake and arranging them this way gives the optimum layout for the PCB.

Switch board assembly

There just four parts on the switch board – the three pushbutton switches on one side and the 14-way IDC header socket on the other (see Fig.14).

The three pushbuttons can go on first but note that they must be installed the right way around. These have "kinked" pins at each corner plus two straight pins for the integral blue LED. The anode pin is the longer of the two and this must go in the hole marked "A" on the PCB.

Once the pins are in, push the buttons all the way down so that they sit

flush against the PCB before soldering their leads. The IDC header socket can then be installed on the other side of the board, **with its key-way notch towards the bottom.**

Initial checks

Before installing the three ICs on the preamp board, it's a good idea to check the supply voltages. If you haven't built the power supply yet, you can either use a suitable dual-rail bench supply or skip until the final assembly in the chassis.

Assuming you do have a power supply, connect the +15V, -15V & 0V leads to CON6 and switch on. Now check the voltages on pins 8 & 4 of the two 8-pin IC sockets; ie, between each of these pins and the 0V (centre) terminal of CON6. You should get readings of +15V and -15V respectively.

Similarly, check the voltage on pin 14 of IC3's socket. It should be between +4.8V and +5.2V.

If these voltages are correct, switch off and install the ICs. Note that IC1 & IC2 face one way while microcontroller IC3 faces the other way.

Making the test cables

Before testing the unit, it will be necessary to make up two IDC cables. Fig.15 shows how these cables are made. Pin 1 on the header sockets is indicated by a small triangle in the plastic moulding and the red stripe of

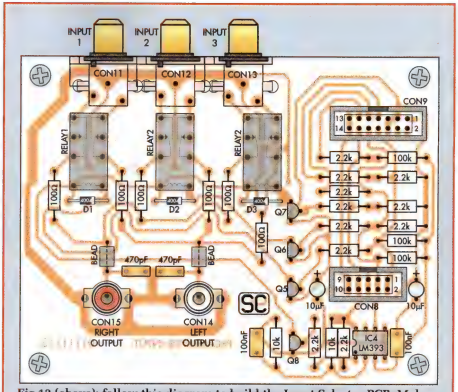


Fig.13 (above): follow this diagram to build the Input Selector PCB. Make sure that the two header sockets are correctly orientated and note that Q5-Q7 are BC327 PNP transistors while Q8 is a BC337 NPN transistor.

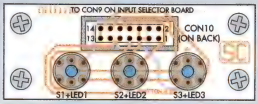
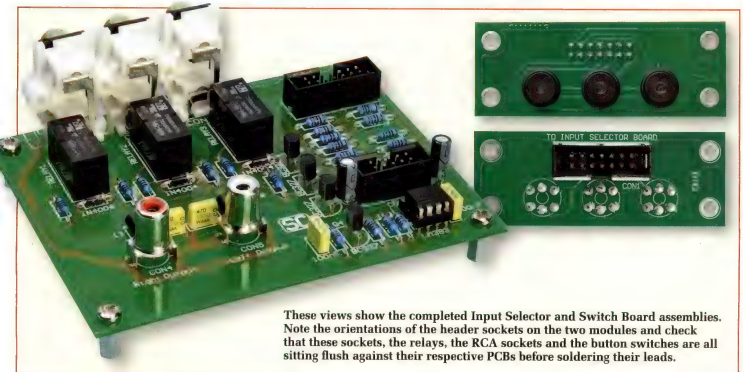


Fig.14: the three switches are mounted on the front of the Switch Board while the header socket goes on the back (key-way towards S2). Take care with the switch orientation (see text).



These views show the completed Input Selector and Switch Board assemblies. Note the orientations of the header sockets on the two modules and check that these sockets, the relays, the RCA sockets and the button switches are all sitting flush against their respective PCBs before soldering their leads.

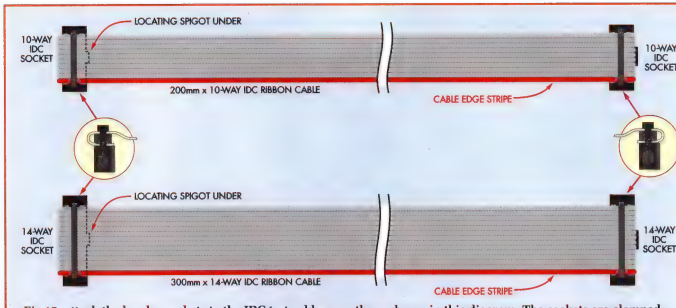


Fig.15: attach the header sockets to the IDC test cables exactly as shown in this diagram. The sockets are clamped using an IDC crimping tool or you can simply use a vice. Don't forget to fit the locking bar to secure the cable after each header is clamped.

the cable must always go to these pins.

You can either crimp the IDC headers to the cable in a vice or use an IDC crimping tool (eg, Altronics T1540 or Jaycar TH-1941). Don't forget to fit the locking bars to the headers after crimping, to secure the cable in place.

Having completed the cables, it's a good idea to check that they have been correctly terminated. The best way to do this is to plug them into the matching sockets on the PCB assemblies and then check for continuity between the corresponding pins at either end using a multimeter.

Remote control/switch testing

The remote control functions can now be tested using a suitable universal remote, eg, Altronics A1012. As stated earlier, the default device mode programmed into the micro is TV but if this conflicts with other gear you can choose SAT1 or SAT2 as the device instead.

Whichever mode is chosen, you must also program the correct code into the remote (see panel).

Note that if you don't have a dual power supply, you can still check the remote control circuit by using a single-rail 9-15V supply connected between the +15V and 0V terminals of CON6 (watch the polarity). As before, check the voltage on pin 14 of IC3's socket (it must be between +4.8V and +5.2V), then switch off and install IC3 (pin 1 towards IRD1). In addition, insert the jumper link for LK3 to enable the mute return function.

That done, rotate VR2 fully anticlockwise and use the remote to check the various functions. First, check that the inputs can be selected using the 1, 2 & 3 buttons on the remote and the S1-S3 buttons on the Switch Board. Each time a button is pressed, you should hear a "click" as its relay switches on and the blue LED in the corresponding switch button should light.

In addition, the orange Acknowledge (Ack) LED should flash each time you press a button on the remote. **If the ACK LED doesn't flash, make sure the code programmed into the remote matches the device mode (ie, TV, SAT1 or SAT2). The ACK LED won't flash at all unless the code is correct.**

Now check that the volume pot turns clockwise when the Volume Up and Channel Up buttons are pressed and anti-clockwise when Volume Down and Channel Down are pressed. It should travel fairly quickly when Volume Up/Down buttons are pressed and at a slower rate when the Channel Up/Down buttons are used.

If the pot turns in the wrong direction, reverse the leads to the motor.

Adjusting trimpot VR2

Next, set the volume control to mid-position and hit the Mute button. The pot will rotate anti-clockwise and as soon as it hits the stops, the clutch will start to slip. While this is happening, slowly adjust VR2 clockwise until the motor stops.

Now press Volume Up to turn the potentiometer clockwise for a few seconds and press Mute again. This time, the motor should stop as soon as the pot reaches its anticlockwise limit.

A programmed time-out of 13-seconds will also stop the motor if it continues to run after Mute is activated. This means that you have to adjust VR2 within this 13s period.

If the motor stops prematurely or runs for the full 13s after the limit is reached, try redoing the adjustment.

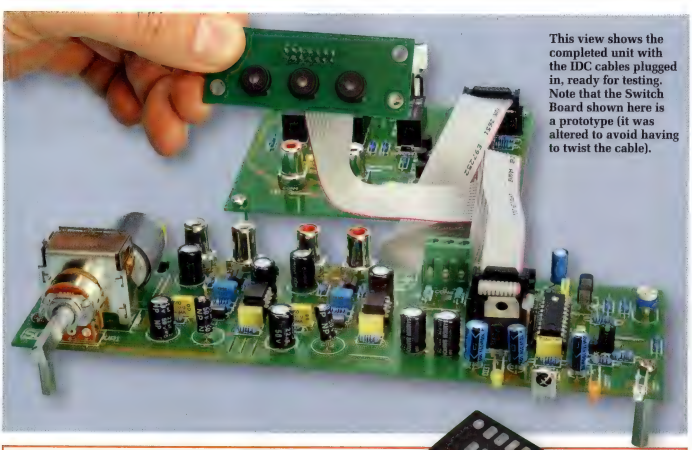
Troubleshooting

If the unit fails to respond to remote control signals, check that the remote is in the correct mode (TV, SAT1 or SAT2) and has been correctly programmed. If you're using a remote other than those listed in the panel, work through the different codes until you find one that works.

If the unit responds to the 1, 2 & 3 buttons on the remote but the button

Motorised Volume Pot.

Altronics has advised that they can supply a dual-gang 5kΩ log motorised pot (Cat.R1998) for the preamplifier. This should be used in preference to a 20kΩ pot and the 4.7kΩ shunt resistors omitted.



This view shows the completed unit with the IDC cables plugged in, ready for testing. Note that the Switch Board shown here is a prototype (it was altered to avoid having to twist the cable).

Selecting The Mode & Programming The Remote

As stated in the text, it's necessary to program the universal remote control correctly. By default, the microcontroller's RC5 code is set to TV but SAT1 or SAT2 can also be selected. Just press and hold button S1 on the Switch Board during power-up for SAT1 or button S2 for SAT2. Pressing S3 at power-up reverts to TV mode.

Once you've chosen the mode or "device", the correct code must be programmed into the remote. This involves selecting TV, SAT1 or SAT2 on the remote (to agree with the microcontroller set-up) and then programming in a three or 4-digit number for a Philips device. That's because most Philips devices (but not all) rely on the RC5 code standard.

Most universal remote controls can be used, including the Altronics A1012 ($19.95) and the Jaycar AR1726 ($37.95). For the Altronics A1012, use a code of 023 or 089 for TV mode, 242 for SAT1 or 035 for SAT2.

Similarly, for the Jaycar AR1726, use 103 for TV, 1317 for SAT1 or 1316 for SAT2.

In the case of other universal remotes, it's just a matter of testing the various codes until you find one that works. There are usually no more than 15 codes (and usually a lot less) listed for each Philips device, so it shouldn't take long to find the correct one.

Note that some codes may only partially work, eg, they might control the volume but not the input selection. In that case, try a different code. In addition, some remotes may only work in one mode (eg, TV but not SAT).

The unit will work with most universal remotes including the Altronics A1012.

For example, if you have a Digitor 4-In-1 remote, you can use 5005 for TV1 or TV2 but there's no suitable code for SAT. Similarly, if you have a AIFA RA7, you can use 026 for TV1 or TV2 but again there's no suitable code for SAT that works.

switches don't work, check the IDC cable from the Switch Board. Similarly, if the remote volume function works but not the remote input selection, check the IDC cable from the preamplifier.

Note that the cable from the preamplifier also supplies power to the Input Selector board. Check that there is 5V between pins 8 & 4 of IC4 on the Selector Board and again check the IDC cable if this supply rail is missing.

Audio testing

If you have a ±15V supply, you can test the preamplifier by connecting its outputs to a stereo amplifier and feeding in audio signals from a CD player.

However, note that the left and right channel audio grounds are not connected to the 0V rail at CON6 on the preamplifier PCB. That's necessary to avoid a hum loop, since the two audio channels are normally earthed back through the power amplifiers via the signal leads. This means that, to test the unit, you must temporarily connect the audio grounds at CON1 & CON3 to the power supply 0V rail (eg, the tab of REG1) using clip leads. SC

Vintage Radio

By Maurie Findlay, MIE Aust, VK2PW

AWA R7077 Beat Frequency Oscillator

It was 1939 and Australia was at war. Its future seemed far from secure and every industry in the country was geared to support the military effort. Amalgamated Wireless Australasia (AWA) played a key role by designing and producing vital communication equipment.

THE R7077 Beat Frequency Oscillator (BFO) described here was a very small part of the company's output during the early 1940s. This well-made piece of test gear provides a good example of the techniques that were available at the time. Vacuum tubes (valves) were by then well-developed and reasonably reliable but the transistor hadn't been invented.

Indeed, it would be another 20 years or so before equipment using semiconductors became available.

As a radio amateur after the war, I acquired a number of pieces of AWA equipment through the disposals outlets and adapted these for use on the amateur radio bands. I also remember having a famous American communications receiver (HRO) and an AWA receiver made in the same general format (AMR100). The workmanship and general quality of the Australian-made set was better than the original.

AWA's associated company AWV manufactured valves locally and many, particularly those designed for battery operation, were more reliable than overseas types intended for the same job.

The R7077 BFO

A handbook describing the R7077 BFO at the time lists the features, applications and design of the instrument and these are summarised in the accompanying panel. It is interesting to note the technical style used in the 1940s, long before terms such as "Hertz" were introduced, both in the panel and in the following text which is also derived from the leaflet:

The audio output is produced by mixing the outputs of two high-frequency oscillators, selecting the lowest frequency component of the output and amplifying it to a suitable level.

One oscillator remains fixed at 100kc, and the other is variable from 100kc to 86.5kc by means of a variable condenser. The plates of this are shaped to give an approximately logarithmic law to the beat frequency scale calibration.

Frequency drift, due to variations of temperature and supply voltage, is reduced to a minimum by using silvered mica condensers and robust coil formers in the tuned circuits. In addition, a symmetrical layout is used for the two oscillators.

Both oscillators are of the resistance stabilised tuned grid type, using a triode oscillator electron coupled to a heptode buffer amplifier. A type 6J8G valve is used in each oscillator circuit, which allows the oscillator and buffer amplifier to be accommodated in the one valve. The output of each oscillator is fed to the mixer valve, the variable oscillator output being taken directly and the fixed oscillator output reaching the mixer through a filter.

A low-pass filter placed between the

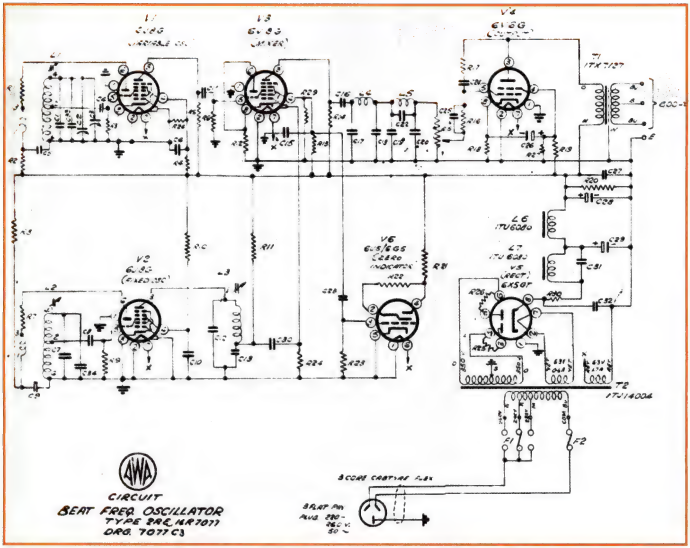


Fig.1: the original circuit from the AWA handbook. The signals produced by the variable and fixed oscillators (V1 & V2) are mixed in V3 and fed to a 6V6G audio output stage (V4). V5 is the rectifier, while V6 is a "magic eye" beat indicator.

mixer and the output stage effectively prevents high-frequency components in the mixer output from reaching the output valve.

Inverse feedback is applied to the output stage, which is a beam tetrode (6V6G). This results in a reduction of the output harmonic content, improvement in frequency response characteristic and stabilisation of output impedance.

Specifications

The specifications also make interesting reading, as shown in a second panel. It's not so impressive by 2011 standards but that's only to be expected. And remember, this was wartime and in addition to applications in the military, the instrument was also quite usable for general audio work, just covering the audible frequency range (10Hz – 13.5kHz).

By contrast, modern audio signal generators have a much greater frequency range (eg, up to 200kHz) and distortion across the range is better than 0.5%. An attenuator and meter to allow low-level signals to be generated accurately would also be included in some of the more expensive models. In addition, a total power consumption of 5W and a weight of about 3kg would be typical of a modern audio generator.

Getting it going again

My R7077 BFO was picked up in a

Features

Frequency range 10 cycles to 13.5 kc.
Directly calibrated 9-inch diameter semi-circular frequency scale, with direct and 44 to 1 reduction drives.
Low relative frequency drift of oscillators.
600 ohm output impedance.

Application

Typical applications of Beat Frequency Oscillator R7077 are the measurement of audio amplifier characteristics and modulation of transmitters and signal generators. The oscillator is also suitable for use in the operation of AC bridges and in conjunction with Cathode Ray Oscillograph R6673 forms part of the equipment for frequency measurement.

Specifications

Frequency Range: 10 cycles to 13.5 kc.

Accuracy: 2% from 30 cycles to 13.5 kc; 10% below 30 cycles

Power Output: 250 milliwatts maximum.

Output Impedance: 600 ohms balanced.

Harmonic Distortion: For 2V across 600 ohms: 4% at 50 cycles, 1% at 400 cycles and higher.

For 10V across 600 ohms: 10% at 50 cycles, 3% at 400 cycles and higher.

For 10V across 50,000 ohms: 10% at 50 cycles, 1.5% at 400 cycles and 1,000 cycles, 2% at 7.5 kc.

Frequency Response: 2db from 30 cycles to 10 kc.

Noise Level: 40db below a reference level of 6 milliwatts.

Radio Frequency Content: From fixed oscillator – negligible. From variable oscillator – 0.05 V across 600 ohms.

Power Supply: 200-260 V, 50– 60 cycles.

Consumption: Approximately 36 watts.

Valves: The following valves are supplied with the instrument: 3 – type 6J8G, 1 – 6V6G, 1 – 6X5GT, & 1 – 6U5/6G5.

Finish: Case – grey wrinkle. Front panel – polished grey with white lettering. Control protecting handles fitted.

Types: 3R7077 – Portable 12" x 8" x 8" case weight 24lbs. 3R7077 – Rack mounting type, 19" x 10" x 8 ¾"

junk store for a few dollars. Externally, it looked to be in good condition except for the power flex which had lost so much insulation as to be dangerous. Inside, all seemed original and with the schematic diagram stuck inside the case, the chances of getting it to work seemed good.

When it came to the minor components, I reasoned that the 14µF electrolytic capacitors in the power supply (C28 & C29) were the most likely to have deteriorated. By now, they probably had low capacitance and high leakage and so they were disconnected and modern types wired into place under the chassis. The power cord had also deteriorated and this was replaced with a 3-way flex/plug combination, with the earth lead securely connected to the metal chassis.

Checks of inductors L1-L5 indicated the expected resistance but the primary of the output transformer was open circuit. As a result, a speaker transformer (5kΩ:3Ω) that had been salvaged from an old broadcast receiver was wired in place of T1. This was connected in a temporary fashion so that the screen of the 6V6G would not be damaged with the high-tension applied.

The resistance from the cathode of the 6X5GT (pin 8) to the chassis measured about 20kΩ (due to voltage dividers across HT line), while the resistance from the primary winding of power transformer T2 to the chassis was greater than 10MΩ. This indicated that the power transformer was probably OK, so the 230V power was applied and all the valve cathodes glowed an encouraging dull red. However, the 6U5 zero beat indicator at the front panel gave only a hint of its normal green colour.

What's more, an oscilloscope connected across the output terminals indicated that there was no audio output from the instrument. The time had come for a systematic check through the circuit with a multimeter.

Troubleshooting

The high-tension (HT) line measured about 250V and the cathode of the 6V6G about 3V, suggesting that both the 6V6G and the 6X5GT rectifier were in good order. Next, the plate and screen voltages of V1 (the 6J8G variable oscillator) were checked and these gave readings close to 170V and 80V respectively, suggesting that the valve was doing its job.

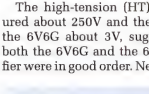


Fig.2: this diagram shows the connections for the alternative octal-base Y61 zero-beat "magic-eye" indicator.

It was a different story, when the voltages on the plate and screen of valve V2 (another 6J8G) were checked. They were much higher than they should be, indicating that its emission was low. I had a spare and when this was substituted, the voltages returned to normal and the scope then indicated the presence of an audio signal at the output terminals.

Obtaining spare parts

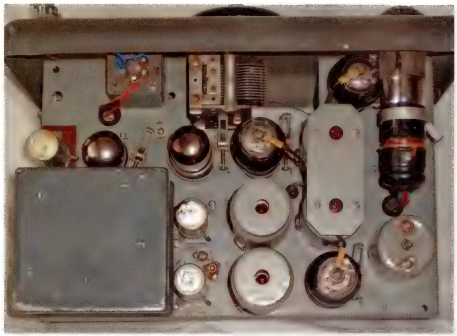
Obtaining replacement electronic parts for the R7077 BFO is usually not a problem. All but one of the valves were made in large quantities and are still generally available. Most valves made even 60 or more years ago seem to still be in good working order if they have not had a great deal of use. The best source is a friend who is an enthusiast but you can also find dealers on the internet who can supply valves at a reasonable cost.

The exception is V6, the 6U5/6G5 zero beat indicator, which tended to have a short working life. The circuit diagram suggests that a Y61, which has an octal rather than a 6-pin base, can also be used. I didn't have either but I did have a similar type with a 12V heater and an octal base (1629/VT-138). But where could I get the 12V?

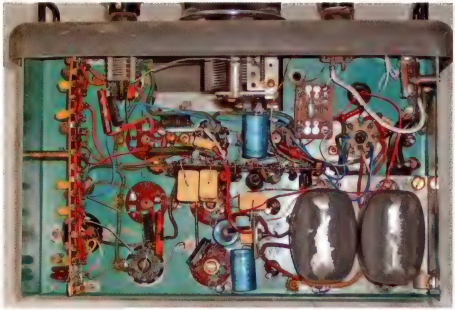
Fortunately, AWA engineers at the time tended to be very conservative and I was able to come up with a solution. The 6X5GT rectifier is provided with a separate heater winding, despite the valve being rated to withstand the high-tension voltage between heater and cathode. I took advantage of this and connected the 6X5GT's heater in parallel with the other valves. This left a 6.3V winding free to connect in series with the main 6.3V winding to provide 12.6V for the 1629 (its connections are the same as for the Y61).

A general check around the circuit revealed a few resistors which were high in value and these were replaced with modern types, using the closest resistance from the preferred value series. The output level control (R15, 0.1MΩ) proved to be intermittent and was replaced with a unit incorporating a double-pole mains off/on switch.

Coils L1-L5 are unlikely to go open



This top view of the chassis shows the robust construction techniques used in the R7077. The valves are all held in place by clamps, so that they cannot come loose as the unit is moved about.



Only a few parts under the chassis required replacement. These included the power supply electros, a few resistors which had gone high and the output level control. Valve V2, the zero beat indicator (V6), the power cord and the output transformer also required replacement .

circuit but it would be possible to hand-wind replacements if necessary (a rather messy job). Filter chokes L6 and L7 are also unlikely to be faulty but their inductance is not critical and something to do the job will be found in many junk boxes. If they are not doing the job, there will be 100Hz hum at the output terminals.

A replacement for the power transformer (T2) is no longer available from parts suppliers but it is similar to the transformers used in many valve AM receivers. So scrounging a working unit from an otherwise defunct radio receiver shouldn't be too much of a problem.

Finding suitable replacements for the mechanical parts may not be so easy. However, it's worth remembering that the 75mm control knob, with the 44:1 reduction mechanism, was

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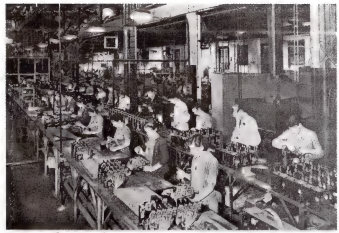
This war-time photo shows the AWA Works Cafeteria at Ashfield. Meal breaks were staggered to cater for the large staff numbers involved and for shift workers.



A general view of one of the assembly lines in the Radio Electric Works, at AWA's Ashfield factory. Many types of transmitters and receivers were built here during the war.

used in several pieces of equipment manufactured by AWA in the 1940s. If this proves faulty, it should be possible to find a replacement although it may take some tracking down. This usually won't be necessary though because it has proved to be reliable.

Output transformer

That leaves the serious problem of the output transformer, T1. It is unlikely that an exact replacement for this unit (type 1TX7127) can be found. The temporary speaker transformer that I installed worked but the output from the BFO was much lower than the specified and fell off even further at lower frequencies.

The specification for T1 is not given in the literature and all I can do is to go back to fundamentals. The 6V6G is operated with a low screen voltage and the plate current is only about 15mA, which means that the optimum load resistance is not the usual 5kΩ. To determine the best load, a set of curves for the valve for a screen potential of around 50V would be needed and as far as I know, no such curves have been published.

As a result, all I can do is rely on experience and make an informed guess. In my opinion, the optimum load would be around 15kΩ and so the impedance ratio of the transformer would then be 15,000 divided by 600. This gives an impedance ratio of 25, while the turns ratio would be five.

The easiest solution is to find a speaker output transformer with the highest primary impedance rating possible. The output of the instrument would still be much lower than specified but it would still would be useful for jobs such as checking resonances in loudspeakers.

Modifying an existing unit

Modifying an existing speaker transformer is also within reason. It would need to be of the open type, using E & I laminations, and the rated primary and secondary impedances would have to be known. The low impedance winding is always on the outside – if you remove this, counting the turns as you go, you can then calculate the number of turns on the primary.

The number of turns for a 600Ω secondary can then be calculated and wound on, obviously using finer wire than in the original (so that the turns fit).

Note that speaker transformers made with E & I laminations have a gap between the two to prevent saturation of the magnetic materials due to the direct current flowing in the primary winding. This gap is provided by a piece of insulating material. The plate current of the 6V6G is only 15mA and the best result will be obtained by replacing the material with something as thin as possible, even tissue paper.

Modulation source

In my case, I often use the restored R7077 BFO as an external modulation source for a signal generator, when checking the audio response of radio sets. The audio range is covered in one sweep of the dial. Besides, it is interesting to preserve some Australian electronic history. SC

This photo shows workers building sub-assemblies on another of AWA's war-time production lines.

PRODUCT SHOWCASE

Local PCB prototyping & manufacturing

At SILICON CHIP we often have enquiries from readers looking for companies that provide a complete prototyping and manufacturing service and now we are pleased to feature just such a company: National Electronic Manufacturing.

They provide a plethora of services to do with electronics manufacturing, from the production of prototypes to full scale manufacturing, in small or large volume. They can produce a range of PCBs with plated-through holes etc as well as assemble boards with the full range of surface-mount devices.

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They are based in Brookvale, Sydney, so they provide the benefit of local assembly and efficient communication with no language barrier, something which can often be lacking if off-shore assembly is being contemplated.

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Jaycar's time-lapse camera makes you the director...

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Order Tel: 1800 022 888 Fax: (02) 8832 3188
Website: www.jaycar.com.au

Rev-Bikes apologises!

The feature on building an e-bike (converting a pushbike to electric power assist) created a large amount of interest but the new website featured (**www.rev-bikes.com**) suffered a few "teething problems" and was not accessible when the magazine came out.

Readers obviously used the phone number in the article to contact the company because they reported an amazing response.

Rev-Bikes apologised for the website problems and assure us that it is now on line for readers to browse (and buy!).

While Altronics' "Eagle Eye" camera/PVR is just the shot for rev-heads!

If the camera at left is intended for "static" applications, this camera from Altronics is exactly the opposite.

It's intended to capture sports action, from the point of view of the person involved. Whether it's as a helmet cam, an on-dash cam, a bike cam . . . in fact, an anywhere-you-like-cam. It comes with a variety of secure mounts.

It's water resistant (not waterproof!) and while a maximum operating temperature is stated (45°!) no minimum is given, so it's obviously ideal for snow sports too.

It offers 1920 x 1080 (full HD) resolution at 30 frames per second or WVGA (848 x 480) at 60fps. It records on an internal SD card (1GB - 32GB) – an 8GB card will store 2 hours at 1920 x 1080 resolution and it sports an internal, rechargeable Li-ion battery with a spare battery just in case!

It's priced at $329 (Cat X0680) and similarly, it's available at all Altronics retail stores or via their website (which also contains a lot more information). A comprehensive user manual is also include with the camera/PVR. *sc*

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Amplifying Bluetooth phone signals

Recently, I purchased a Bluetooth hands-free unit to take phone calls while driving. It is nowhere near loud enough so I built the CHAMP amplifier (from Jaycar's Short Circuits Volume 3) and wired an electret microphone to the input with a 10kΩ resistor to power the electret and a 0.22µF capacitor to couple the signal to the CHAMP. That works well but I wanted more volume so I built the high power 12V amplifier from the same book.

I wired the output of the CHAMP to the input of the high power amplifier but I get lots of hiss coming from the speaker even with the volume all the way down on the CHAMP. When I turn the volume up, I don't get much more volume than from the CHAMP; then it starts to motor-boat. I am bench-testing the set-up with a 12V jump starter pack so the supply is not noisy or weak.

If I disconnect the CHAMP and feed my audio oscillator into the high power amplifier, the thing is as quiet as a mouse and happily gives clean sound when I turn up the oscillator from a low setting. Coupling the electret directly into the high power amplifier doesn't give much gain either as the article states it needs nearly 1V as a signal input.

I have tried all sorts of resistors and capacitors to interface these two amplifiers but I am obviously missing something simple. Can you please give me some advice on this? (G. C., Toormina, NSW).

● Project 13, the preamplifier from Jaycar's Short Circuits Volume 3, would have been a better choice and should have been used ahead of the power amplifier rather than using the Champ. The Champ is not as quiet as the preamplifier would be.

But since you already have the Champ, it should be modified by adding a 100Ω load resistor at its output to allow the 470µF output capacitor to charge. Also, the GND (ground) wiring should be first run from the negative terminal of the 12V battery supply to the power amplifier and then to the Champ to prevent problems with motor-boating.

We suspect the excessive noise is due to high-frequency oscillation of the Champ. The electret supply via the added 10kΩ resistor should be connected to a decoupled supply consisting of a 220Ω resistor from the switched 12V supply. The free end of the resistor connects to a 100µF capacitor, bypassing the supply from the 220Ω resistor to GND.

Reversing facility for electric car

Some years ago I built my grandkids an electric car powered by a 24V 250W motor. It has done years of reliable service and now is the time to add a reversing feature. I thought of wiring in a 2-pole 3-position (centre off) switch but I could not pass 20A through those that are readily available.

Would you consider designing a solid-state external reversing system with the following features: (a) reverse not selectable until the motor is at rest; (b) an internally adjustable speed limit on reverse; and (c) LED warning lights to indicate FWD and REV? In applications such as wheel chairs etc full speed reverse would be dangerous while in dinghies etc full speed reverse might be useful and safe. (D. V., via email).

● Our Railpower projects from October to December 1999 and the September/October 2008 versions had reverse lockout and lockout indication, plus forward/reverse indication. There was no reverse limit setting. The H-drive circuit for the motor was not

More Scam Products To Prey On The Gullible

I have recently found several "miracle gadgets" on eBay with big claims re generating vehicle fuel savings when installed. Two in particular I was wondering if you could shed some light on (with some analysis of the devices and the supposed claims and whether to refute these or otherwise) are the "Magic Booster" (which appears to be a capacitor type device that gets placed across the battery terminals for voltage smoothing) and the "Universal Magnet Gas Fuel Saver" (a magnet which gets strapped to the fuel line).

I am very sceptical of the claims made for these devices and wonder if you would do an article on them? (M. R., via email).

● Unfortunately, products such as the Magic Booster and Universal Gas Fuel Saver are just scams.

As you have surmised, the Magic Booster is most likely a capacitor. But for a capacitor to have a substantial filtering effect compared to a car battery, its internal impedance (or "equivalent series resistance" if you like) would have to be substantially lower than the car battery itself. That is a huge ask since a well-charged car battery has an extremely low internal impedance – maybe 20 milliohms or less.

If the capacitor was to have a lower internal impedance it would have to be truly enormous and measure many, many Farads. In truth, the only way to obtain a lower source impedance than a car battery is to use – wait for it – a much bigger battery.

As far as the fuel magnet is concerned, this is total rubbish. A magnet, no matter how powerful, cannot cause any chemical compound to break into ions. It just doesn't happen.

Interestingly, these products work equally well on all brands of cars, since they don't work at all.

rated for the current required to drive a 24V 250W motor but this could be upgraded by using TIP35C (25A NPN) and TIP36C (25A PNP) transistors. The current limit would also require changing, with a lower value current sensing resistor.

Fuse rating for headlight reminder

I recently purchased a Headlight Reminder kit (SILICON CHIP, August 2001) from Jaycar Electronics. I am currently installing the device and have a question. The instructions state to connect the power wire via the fuse box but there is no mention of the applicable fuse rating. Please advise what fuse rating I should use.

I think an improvement to this product would be to provide an in-line fuse (your installation instructions advise to use automotive quick connectors to make the tappings into the existing wiring. An in-line fuse would eliminate which side of the fuse box the connection was made).

- Generally you would select a fuse that has a low rating because the Headlight Reminder draws minimal current. So a 1A or 2A fuse connection would be suitable. An added in-line fuse to the headlight reminder would only need to be 200mA or a similar rating.

Hash-free inverter wanted

Many moons ago a reader suggested that you develop a 12V to 230VAC inverter project. Predictably the idea was rejected on the basis that inverters of every type were readily available.

As a result of some experience gained recently, I now side with your reader. I was tasked with setting up a PA at our local cenotaph where 230VAC was not available. Tests with four inverters, three of which were "pure sinewave", rendered the PA useless due to the severity of background hash and noise which overrode the mic output. The problem was eventually solved by using a 24V 60W amplifier powered by batteries from a wheelchair.

How about putting the inverter project back on your list? Why is it that present-day inverters are so noisy when there is no spark in the system? In my innocence, I assumed that inverters would have a couple of 2N3055s oscillating into the primary of a suitable transformer. The "upmarket" version might have an oscillator triggered by a 50Hz pulse traceable back to a crystal or other stable source, both versions having a perfectly clean waveform output. Or would they? Am I missing something here?

If you won't or can't develop a clean inverter project, then how about looking at a filter which removes the rubbish from commercial inverters? (D. V., via email).

- The reason why inverters radiate interference is that they have Mosfets or IGBTs (insulated gate bipolar transistors) which switch very rapidly. In sinewave inverters, the sinewave is generated by IGBTs in an H-bridge circuit which are driven at high frequency in a switching sequence which is averaged out in a low-pass filter. The result is a 50Hz sinewave.

Either your PA system is very sensitive to EMI or the EMI radiated by the inverter is too much. A good mains filter might help. We also wonder if the PA's mic cables go to balanced inputs – this should have reduced any common-mode noise from EMI.

Defective LCD in Digital LC Meter

I built the Digital LC Meter from your May 2008 issue. On power up the LCD screen only shows a line of small square dots. I have carefully checked everything, with nothing obvious. The PIC16F628A micro programmed "No Fault" and all power and grounds as per circuit diagram check out OK. What further checks I can do? (T. Q., via email)

- Those symptoms suggest that the LCD is not receiving the necessary data signals to enable it to show the information sent by the microcontroller.

Check that Rs (pin 4) on the LCD connects to pin 11 on IC1 and that EN (pin 6) connects to pin 10 on IC1. Check also that data pins D4-D7 (pins 11-14) on the LCD connect to pins 9, 8, 7 & 6 of IC1. There may be a break in a connection or a short between pins.

Finally, check that D0-D3 (pins 7-10) on the LCD are connected to ground.

Regulator problem in Battery Capacity Meter

I built the Battery Capacity Meter featured in June & July 2009 and have had problems getting it to turn on (only bars on the LCD screen). It sometimes comes on when connected and then you can input the settings but next time you connect it, no go.

By chance I found that the 5V rail was at 5.9V so I changed the 5V regulator. It then worked for a few weeks but now the regulator has failed again and the supply is back up to 5.9V.

When it is working, the drain of

Using The Battery Capacity Meter At Lower Voltage

I am very keen to build the Battery Capacity Meter from the June & July 2009 issues for my blind foundation charity. Is it possible to modify the voltage level from 9V down to 7.2V for NiMH batteries which charge up to 9V when fully charged? Does any supplier make a kit for this project? (M. M., via email).

- The voltage range from a 6-cell NiMH battery is probably too low. With six cells, the voltage is typically 7.2V charged (1.2V per cell) dropping to 6.6V (1.1V per cell) when discharged. The battery may rise to 9V under charge but under load and when there is no charging current, its voltage will typically be 7.2V.

Regulator REG1 which provides the 5V supply is the main problem in that it only operates from 7V to 60V. The MAX4080's (IC2 & IC3) will run from between 4.5V and 76V, so they are OK.

REG1 could be changed for a low drop-out linear regulator such as the LE50ABD. This is in a surface-mount SO-8 package and draws 50µA in standby using the inhibit pin in the same way as the original LM2574 regulator (which also draws 50µA on standby). The regulator is only suitable for 100mA output though and so the LCD backlighting would have to be restricted to a low level by increasing the 10Ω resistor at the LCD ABL pin to 47Ω or more.

The LE50ABD does not directly fit onto the PCB but will operate down to 6V and up to 18V. The component is available from element14: **au.element14.com**

Phono Cartridge Loading Capacitance Is Important

I am trying to determine the phono input capacitance on my Luxman L-410 amplifier. I am aware that I have to take into account the total capacitance of the tone-arm wiring and interconnect cables which I can measure (around 120pF).

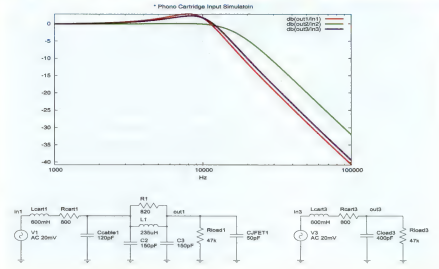
My Ortofon VMS 20E Mkll requires a resistive load of 47kΩ (no problems) and a capacitive load of 400pF. I don't have the necessary null bridge to measure the amplifier input capacitance so I am trying to deduce it from the circuit diagram.

The signal from L or R goes directly to the base of an FET at the start of the preamp chain. Can I assume that the input capacitance from this circuit is 300pF (150pF + 150pF in parallel); or if the 0.047μF capacitor comes into play, 298pF? Or is this reasoning just too simplistic? If my logic is correct, then it seems that I have the ideal loading without the use of the 210pF additional capacitor supplied by Ortofon (CAP210).

I can measure the tone-arm and interconnect cables using my Brymen multimeter. However when I connect it across the phono input terminals of the amplifier, the "auto sensing" jumps around the capacitance ranges but "finds" nothing, with the amplifier switched on. It is not essential that I know the precise input capacitance as I'm not planning to fine-tune it. What I am trying to do is determine whether the Ortofon-supplied 210pF "clip on" capacitor should be used or not.

Therefore I only need to know if the input capacitance is 100pF, in which case I would need the cable (120pF) and the Ortofon 210pF to achieve the target of around 400pF. However, if the input capacitance is 300pF then the additional capacitor is unnecessary.

What makes me suspicious of my simplistic calculation of 300pF from the schematic is that this is a high figure and would be unsuitable for many MM cartridges which typically



only require 100-200pF maximum loading. Ortofon is somewhat unusual in requiring 400pF and their knowing that most amplifiers/cables have lower capacitance is the reason they supply the additional capacitor. (M. F., via email).

● Because you have piqued our interest we decided to answer this query in more detail than normal.

First of all, we thought that the total input capacitance of the amplifier is likely to be around 350pF, when allowing for about 50pF of gate capacitance for the input junction FETs. Taken with your tone-arm and connecting cable capacitance, this gives a result of about 470pF which is probably too high for the Ortofon VMS-20E.

But rather than just leave it at that, we decided to simulate your cartridge when driving the total tone-arm and connecting cable capacitance plus the amplifier's input capacitance. In fact, we suspected that Ortofon's recommended capacitance loading for the cartridge was itself too high and was likely to give a response peak that was too low in frequency, leading to excessive loss of treble above 10kHz.

Anyway, we plugged all the details into *NGSpice* simulator and ran it. As we suspected, the resulting peak was too low, at around 7kHz (red trace).

Just to check our figures, we also ran the simulation with the Ortofon driving the recommended 47kΩ and 400pF. This was better, with the peak at about 8kHz (blue trace) but that is still not good. Finally, we ran the simulation with the cartridge driving your Luxman amplifier but with the two 150pF input capacitors removed. This gave the best result of all, with no peak and a gentle rolloff above 10kHz to -5dB at 20kHz (green trace).

The accompanying simulation diagram shows the results. Note that the simulated results are not what the cartridge actually delivers because its mechanical resonances will also come into play. But the electrical resonance depicted in the simulations certainly will play a big part.

By the way, your Luxman amplifier, a mid-1970s design, would now be pretty ordinary in its performance, especially compared to the latest SILICON CHIP designs.

This reader followed up our answer with the following letter:

I thought you may be interested in

. . . continued on page 112

the circuit is 39mA, so the regulator is not overloaded. Can a normal 7805 regulator be adapted as I don't need a high-voltage input, only 12V? Each time the regulator fails the input values are corrupted. Why is this so? (E. L., via email).

● The LM2574HV-5 5V regulator has been specified because we are using its shut-down feature to reduce current drain during standby. The regulator is possibly being damaged due to flywheel diode D8 not being able to clamp negative voltage effectively. Check that this diode (1N5819) is OK

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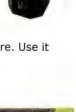

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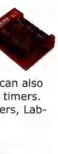

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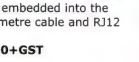

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Notes & Errata

Programmer for dsPICs & PICs, May 2008: Table 4 showing the jumper settings is incorrect for PICs requiring the external adaptor PCB (ie, the 10F, 12F and 16F63X/67X/68X devices). The V_{pp} connection must be selected using either JP4 or JP3.

For example, for the PIC12F675, JP3 should be inserted to connect its pin 4 to the V_{pp} supply. Check the data sheet for the device you are using to verify which pin is V_{pp}.

Stereo DAC (September-November 2009): the 300Ω resistor across CON1 should be changed to 82Ω for improved coaxial cable termination. This affects Fig.2 and the parts list in the September 2009 issue, as well as Fig.5 and Table 1 in the October issue.

Two TOSLINK-S/PDIF Audio Converters (October 2010): the 300Ω resistor on the S/PDIF to TOSLINK board should be changed to 82Ω for improved coaxial cable termination. This affects Fig.1, Fig.3, Table 1 and the parts list.

Quizzical (October 2011): in the specifications panel on page 18 it states that the Quizzical can handle SD cards up to 2GB. While correct at the time, Tenda Electronics have advised that the latest TDB830 MP3 modules will now handle SD cards up to 8GB.

using the diode test on a multimeter.

Also, this diode will be able to protect the regulator best if it is connected beneath the PCB directly between pins 7 & 4 of REG1 (anode to pin 7).

Crock-pot temperature controller wanted

New modern crock-pots run quite hot compared to older models from a couple of decades ago. This means you have to substantially fill a modern one with food or risk burning the food. Also the cooking time is a lot less now (4-6 hours) compared to older ones (8-12 hours) cooking the same quantity of food.

It would be good if there was something that could sit between the power point and the newer crock-pots to control the temperature, so that new models could mimic the behaviour of older models. Cooking for longer at a lower temperature gives better results. I did think of trying something like a drill-speed controller but a drill is a different device to a heating element, so I didn't want to risk it.

Our new crock-pot now sits unused while the old one still gets plenty of use but is slowly falling apart. A project like this would earn any bloke lots of points with his partner I'm sure. Any chance you could look at it? (R. M., via email).

● The editor has a modern 6-litre crockpot at home which gets a lot of use. It also has different heat settings. Yours doesn't? To get the final answer, he referred to a higher authority (ie, spouse) and was told that you need to use more water in the mixture, to avoid it drying out.

In any case, we have published a suitable controller, the Heat Controller from our July 1998 issue. It works by zero-voltage switching a Triac. If you need more power adjustment, it would certainly do the job.

By the way, there is a major hazard for crock-pots if they are used too close to induction cook-tops. In one case we know of, a crock-pot was placed on top of an induction cook-top which had been left on a low setting. The power induced into the metal casing of the crock-pot caused it to boil over.

Charged cells should not be too hot

I have built the Cordless Power Tool Charge Controller, (SILICON CHIP, December 2006) and it appears to work fine. However, I have one question about the adjustment of VR2 (which I have set to 2.5V as per the instructions) regarding the battery temperature.

In the instructions on "Setting Up", it instructs you to "turn VR2 anticlockwise if the battery pack appears to get hot after full charge has been reached". I am charging a nominal battery pack of 12V with a 13.5V 400mA plugpack and have set TP1 at 3V which equates to 15 hours.

Mine gets warm but how hot is too hot? Is there a temperature maximum I should be looking for with a temperature probe? (M. V., via email).

● The temperature of the cells when charging is complete partly depends on the ambient temperature. If the cells feel warm to the touch then the setting is fine. If the cells are so hot that the hand cannot be kept on the cells, then they are too hot.

Typically the cell case temperature should be less than 50°C. SC

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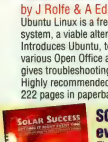

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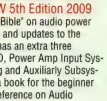

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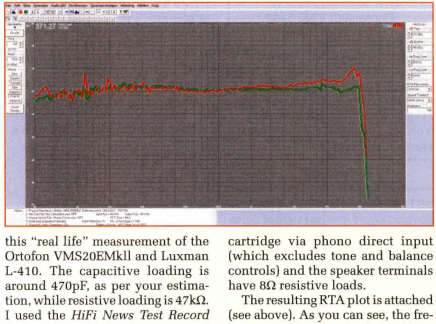

this "real life" measurement of the Ortofon VMS20EMkII and Luxman L-410. The capacitive loading is around 470pF, as per your estimation, while resistive loading is 47kΩ. I used the *HiFi News Test Record* pink noise track for the input and the output fed into the True RTA software (thanks for the great recommendation in October 2011 SILICON CHIP!). The signal path is from the cartridge via phono direct input (which excludes tone and balance controls) and the speaker terminals have 8Ω resistive loads.

The resulting RTA plot is attached (see above). As you can see, the frequency response extends to 20kHz which is well above the electrical simulation and supports the theory that the mechanical (cantilever) effect is significant. **SC**

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